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AMERICAN LOCOMOTIVES ON INDIAN RAILWAYS are reported upon by the Locomotive Superintendent of the Oudh & Rohilkhund Railway, under date of May 17, as follows: For this road ten Mogul locomotives, 6-wheels, coupled, with a Bisel truck, were built by the Baldwin Locomotive Works, and were delivered in May, 1900. At the end of April, 1901, these locomotives had recorded an average mileage of 23,070 miles. The only change made at first was in the firegrates, which did not suit Bengal coal; and new bars, with a ⅞-in. space between, were put in them. Later, certain oil-cups and the sand-boxes were changed to suit Indian requirements. The chief defects pointed out by the Superintendent are as follows: Eccentric sheaves came loose on axle in two engines; vacuum brake cylinder hangers of tender are put on with bolts and nuts so placed as to be impossible to get at with wrench; the nuts have to be tightened up nearly each trip; the engine-cab, while very roomy and comfortable, is not stayed sufficiently and works a good deal with the "constant jolting of the engine." All of these defects seem to result from a very rough track. The average coal consumption on these ten engines, from October, 1900, to March, 1901, was:

Per engine mile.....	48.29 lbs.
Per vehicle mile.....	1.92 lbs.

The new "B" class English engines do the same work as follows:

Per engine mile.....	45.25 lbs.
Per vehicle mile.....	1.94 lbs.

The cost of the American locomotives complete was $12,-614 each, with the rupee = $0.32.4; each class "B" English locomotive cost $14,523. The report concludes as follows:

These ten engines have been working passenger trains, running at 30 to 35 miles an hour, and goods trains running at 20 miles an hour, chiefly the former, and they have done their work well. They steam capitally, and are remarkably good starters; they get away from a station with 55 loaded (equal to about 1,300 tons) with the greatest ease. They are a little higher in coal consumption than our new B class. They are easily repaired, but repairs will have to be kept up, as, if not, they will go to pieces sooner than our other engines would. They do not, as far as I can see at present, cost more in repairs than other engines, and I am very satisfied with them.

THE NEW LOCOMOTIVES FOR THE NEW YORK Central R. R., built by the Schenectady Works, number 22 in all, and the late President of that road, Mr. Samuel R. Callaway, says that in power and speed they so far surpass the best type of European locomotive that the latter can hardly be said to be in the same class. One of these engines recently carried 13 heavy passenger coaches, weighing approximately 1,600,000 lbs., at a speed of 63 miles an hour. This locomotive developed 1,452 HP. during a considerable part of the run. Another of these engines carried 15 passenger cars, weighing about 1,800,000 lbs., and including four heavy sleepers, at the rate of 60 miles per hour. On another run, with a train of ten passenger cars, these engines made the run from St. Thomas to Windsor—111 miles—in 109 minutes.

A THREE-CYLINDER COMPOUND LOCOMOTIVE for the North Eastern Ry., of England, is illustrated in London "Engineering" for July 5. The engine is intended for a great range of service, and is so arranged that it can be worked as a simple engine, as a semi-compound or as a compound engine. When it is operated as a simple engine the high pressure piston is placed in equilibrium and when running as a semi-compound a certain amount of steam is admitted to the low-pressure cylinders direct from the boiler. The duties of the engine driver are very simple. Upon opening the throttle valve steam from the boiler is admitted to the high-pressure steam chests and at the same time flows through a reducing valve into the low-pressure steam chest at a predetermined pressure. On the first exhaust from the high-pressure cylinder this steam is automatically shut off. At starting it sometimes happens that the valve of the high-presure cylinder is not in position to take steam and steam entering the exhaust ports from the low-pressure valve chest would tend to reverse the engine. This is prevented by fitting a non-return valve between the steam ports of the high-pressure cylinder and the steam chest of the low-pressure cylinder; the high-pressure piston is thus thrown into equilibrium until it can take steam from its own valve. To work the engine as a semi-compound it is only necessary to compress the reducing valve spring, thereby admitting steam at a higher pressure to the low-pressure cylinders, and to work it as a simple engine the spring is compressed still further until steam at full boiler pressure is admitted to the low-pressure cylinders. The high-pressure cylinder then works in equilibrium. The most of the work is done when the engine is working as a compound. In starting from a heavy grade, however, the engine may be converted to a semi-compound.

THE NEW YORK DOCK CO., Mr. D. H. King, Jr., President, is incorporated with $30,000,000 capital to enormously improve the New York river front. This company owns about 2½ miles of improved water front on the Brooklyn side, south of the old Brooklyn bridge and including the four principal ferries. While the plans are not made public, it is admitted that much of this work will be done along the Buttermilk Channel, now being dredged to 40 ft. by the U. S. Government. The plans include the improvement of existing docks and the building of new ones of enormous dimensions, with warehouses connecting with railways. The scheme contemplates tunnels under the East River, and possibly under the North River to Jersey City.

THE HAVANA FLOATING DRY DOCK, lately bought by the U. S. Government for $185,000, will be towed to Manila through the Suez Canal. It cost the Spanish government $80,000 to bring the dock from Belfast to Havana; but Lieut. Commander Lucien Young, U. S. N., Naval Commandant at Havana, says that it can be towed to Manila at a less expense.

EXAMINATION FOR ASSISTANT ENGINEER, Grade A, Rapid Transit Commission, will be held by the Municipal Civil Service Commission on Aug. 14 at 10 a. m. Address for application blanks, Mr. Lee Philipps, Secretary, or for further particulars relating to examination, Mr. F. G. Ireland, Chief Examiner, 346 Broadway, New York city.

EXAMINATION FOR EMPLOYEES OF THE U. S. Navy will be held as follows: At the New York Navy Yard, Aug. 7, for a first-class assistant electrical draftsman, at $4.00 per day; address applications to Commandant, Navy Yard, New York, before Aug. 6. At the Navy Yard, Boston, Aug. 7, for two first-class assistant electrical draftsmen, at $4.00 per day; address Commandant, Navy Yard, Boston, Mass., before Aug. 6. Examinations will also be held at a place and date to be fixed for first-class copyist electrical draftsmen, at $3.28 per day; second-class same at $3.04 per day, and third-class same at $2.80 per day. By applying to the Navy Department, Washington, D. C., the applicant can obtain Extract from Navy Yard Order No. 225, giving the requirements, system of marking, etc.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Baltimore & Ohio R. R. at Marriottsville, Md., on July 26. The locomotive of a local passenger train was derailed, resulting in the death of the engine driver and the serious injury of the fireman.

AN EXPLOSION AND FIRE DESTROYED the American schooner "Louise Adelaide" at Stockholm, Sweden, on July 23, resulting in the deaths of 15 persons. The ship was laden with petroleum. She was built at Yarmouth, Me., in 1882, and was 154 ft. long, with 34-ft. beam.

AN EXPLOSION OF PETROLEUM is reported to have destroyed the town of Batum, Russia, on July 25. Batum has a population of 28,000, and is situated on the Black Sea, near the Baku oil fields.

BIDS FOR LARGE GARBAGE FURNACES at Calcutta, India, are to be received until Dec. 31, 1901. Each furnace must have a capacity of 200 (long) tons a day and must be operated by the contractor for three years before final acceptance and payment by the city. The city will deliver the refuse at the furnaces and will pay by the ton for all garbage so delivered, the price to be the same as that named by the successful bidder. After the furnaces have been operated for a year the city will pay one-half the contract price, but the balance will be held until the expiration of the three years, when three arbitrators will decide whether the contractors have fulfilled their obligations. In case of a successful experience the city proposes to establish furnaces with a total capacity of 1,000 tons a day. Mr. Fred. Gainsford is Secretary to the Calcutta Corporation.

OPPOSITION TO SEWAGE FARMING at Los Angeles, Cal., has been getting quite pronounced of late. The city council recently made or modified a contract which involves the use of sewage for irrigation on certain truck farms near the city. The action recognized the feeling against the practice in certain quarters by providing that no sewage should be utilized within less than 1,600 ft., instead of 600, of a certain portion of the city line. The county board of health had prohibited, apparently, some time ago, the use of sewage on all table vegetables which are to be eaten uncooked, but neither this nor the extension of the limit just named fully satisfies some of the citizens. Accordingly, one of the churches near the irrigated area has passed a resolution condemning "the action of the city council with regard to sewage irrigation" and declaring that "it is extremely filthy, a menace to health, and ought to be stopped at once." The distribution of the sewage in open ditches, and the alleged stench therefrom, appears to be largely responsible for the agitation. But in addition it is urged that the Chinese market gardeners, who buy sewage from the South Side Irrigation Co., and others, cannot be trusted to observe the county health regulation, mentioned above, and further that owing to the prevailing system of exchange between Chinese gardeners no one is able to tell whether or not he is buying vegetables from sewage-irrigated areas. Mr. Harry F. Stafford is now city engineer of Los Angeles.

WATER METERS FOR ALL CONSUMERS at Ft. Worth, Tex., are proposed, and the water-works committee of the city council, superintendent of water-works and city engineer have been instructed to secure bids for enough meters to cover the city. The council has also voted to contract with Mr. Daniel W. Mead, M. Am. Soc. C. E., First National Bank Building, Chicago, for an artesian well supply, to have a daily capacity of 3,000,000 gallons. The contract price is $119,000. The plan is to buy and place the meters in monthly installments, so the work will be completed by the time the proposed new artesian well supply becomes available. Mr. John B. Hawley, M. Am. Soc. C. E., is city engineer of Ft. Worth.

THE BOSTON TRANSIT COMMISSION has decided upon the State Street route for the Eastern Boston tunnel, as against the Fleet and Hanover Streets route as at first proposed. The recent borings on State St. are favorable, and this route will furnish a better connection with the elevated railway system. As the East Boston tunnel has only reached the water line on the East Boston side, the tunnel may be deflected across the harbor to Long Wharf without trouble.

ELECTRIC SHOCK from touching an incandescent lamp socket resulted in the death of Edward Walsh at Providence, R. I., on June 8. Testimony recently taken during the coroner's inquest brought out the fact that the wiring of the building in which the accident happened was in full accordance with what were until a short time ago the requirements of the fire underwriters. The house was supplied with current at 104 volts from a static transformer, the voltage on the primary of the latter being 2,000 volts. The secondary circuit was not grounded, since such grounding was until recently prohibited by the insurance companies. Walsh stood on a damp basement floor and upon reaching up to turn on a lamp was shocked to death. Investigation revealed the fact that the insulation between the primary and secondary windings of the transformer had been punctured by a lightning discharge a few days previously, so that Walsh probably received the full 2,000 volts. Had the secondary been grounded nothing more serious would have happened than the blowing of some fuses at the time of the lightning discharge.

THE PROPOSED ELECTRIC LIGHTING of the Yosemite Falls is causing some adverse comment as a desecration of the natural charms of this California wonderland. The Engineer of the Commission, however, Mr. Corey, is preparing for bids for four searchlights so placed as to light the falls from top to bottom; and also for the placing of about 700 incandescent lights in and about the hotels and cottages. He denies that these will in any way interfere with scenic effects, but would rather add to the comfort of visitors.

THE CHICAGO RIVER IMPROVEMENTS, suggested by Major Willard, U. S. Engineers, in his report to the War Department, include the dredging of the river and harbor to a depth of 26 ft., but not until after the obstructing tunnels have been lowered or removed. He also proposes the construction of basins in each branch of the river, for the purpose of turning large vessels, as there is great need of such facilities. The cost of building these basins is estimated at $500,000.

CONCRETE-STEEL BRIDGES IN PORTO RICO.

By Edward Thacher, M. Am. Soc. C. E.*

On Dec. 4, 1899, the writer entered into a contract with W. V. Judson, Captain Corps of Engineers, U. S. A., President Board of Public Works, to build two concrete-steel bridges, Thacher patent, on the island of Porto Rico. Both are located on the military road leading from San Juan to Ponce, one over the Jacaguas River at Juana Diaz, and the other over the Guayo River, between Juana Diaz and Ponce. The Jacaguas River bridge has three spans, the center span has a length of 120 ft. and a rise of 12 ft., and each of the end spans has a length of 100 ft., and a rise of 11.28 ft. It has a total length of 404 ft., a clear width of 18 ft., and the grade at the center is 39 ft. above the bed of the river. Work was commenced in February, 1900, and the bridge was completed and opened to traffic on March 7, 1901. The centering of west span was lowered after two months, the deflection was 5-16-in., which gradually increased to ¾-in. in 60 days, after which no further deflection took place. The centering of the center span was lowered after 40 days, and deflected ⅝-in., which increased to about ⅞-in. in one month. The centering of the east span was lowered after 30 days, and deflected ¾-in., which increased to about 1⅛ ins. in two months.

A few days before completion this bridge was tested by the Board of Public Works as follows: 107 bags filled with sand, and from 30 to 60 men, giving a total weight of from 21.5 tons to 23.5 tons, were concentrated at the center and intermediate points of the east 100-ft. span, and at the center of the 120-ft. span, the deflections under this load were about 0.012-in. for the 100-ft. span, and 0.015-in. for the 120-ft. span. These results were considered fully satisfactory by the Board of Public Works, and they did not think it necessary to proceed further. After these tests were completed the contractor made a test by loading all the spans with bull carts, as many as could be crowded on the bridge two abreast, the carts being heavily loaded with stone, the bags of sand also being piled against the parapets and left on the center span. The deflections under this load were as follows: West span, 0.006-in., east span 0.004-in., center span 0.016-in., which were considered satisfactory. The above loads, though not so severe as might be desired, were nevertheless several times greater than can be produced by any prospective tariff, and it was not considered desirable to incur the expense of increased loads.

The Guayo River bridge has three spans, each 70 ft. in the clear. The center span has a rise of 7.5 ft., and each of the end spans has a rise of 7.0 ft. It has a total length of 270 ft., a clear width of 18 ft., and the grade is about 20 ft. above the bed of the river. Work was commenced July 20, 1900, and the bridge was completed on Feb. 9, 1901. The centering was lowered after two and one-half months. No measureable deflection took place when the centers were lowered, nor up to the time the writer left the island, two months later. This bridge was not tested by the Board of Public Works by loading with bags of sand, but was tested by the contractor with loaded carts, on the same day and in the same manner as the Jacaguas bridge, but no measurable deflection took place.

The specifications under which the bridges were built are the same as published by the writer in Engineering News of Sept. 21, 1899, except that the concrete in the piers was changed to 1 cement, 3 sand, 6 broken stone. Concrete or mortar face was used throughout, including the parapets, and the roadways were McAdam 8 ins. thick.

Pile foundations were used throughout, except in the east pier of the Jacaguas bridge, where it was not found practicable to drive piles. When the excavation had been completed, a very compact material, gravel and clay, interspersed with small boulders, was encountered, into which a drill could not be sledged exceeding 1½ ft.; in view of this the Board of Public Works instructed the contractor to proceed with the concreting, and make no attempt to drive piles. With the exception of the east abutment of the Jacaguas bridge, where the excavation was very deep and through clay throughout, all excavations were made through about equal volumes of boulders and clay. The boulders were of all sizes, from one cubic yard to only a few cubic inches, and as a rule became smaller as the excavation progressed, and when they were completed to the depths shown on plans, piles were driven without any great difficulty to a depth of from 12 to 22 ft. The piles were driven until the penetration did not exceed ¾-in. under the blow of a 2,240-lb. hammer falling 25 ft. The cofferdams were in some cases 3-in. tongue-and-grooved plank set on end and driven down as the excavation progressed, and in other cases a curbing of 2-in. plank laid horizontally was used; but the former was found to give less trouble and to be much superior in every way. As none of the foundations were in water at any ordinary stage it was not expected that any great amount of pumping would be required. The foundations for the abutments at Guayo were nearly dry, but all other coundations for both bridges gave a 6-in. centrifugal pump all the work it could do, and in three cases failed to keep the water down, a few feet of concrete being laid under water.

At both bridges the ribs of the centering were supported on pile bents in the channel spans, the piles being driven to refusal with a 2,240-lb. hammer, and sustaining a maximum load of 30 tons at Jacaguas, and much less than this at Guayo. The ribs for the other spans were supported on timber bents, the sills of which rested on a bed of concrete in pits excavated from 2 to 6 ft. in depth, depending on the nature of the ground. The ribs were spaced 6.5 ft. c. to c., and covered with 2 × 4 -in. lagging set on edge. Sand boxes 10 ins. in diameter, and 12 ins. high, with from 6 to 8 ins. of sand were used at all points of support. Sand boxes are very convenient for leveling up and lowering centering, and the writer assumed until recently that they were nearly incompressible, but he now feels that it is not safe to trust them without a good wedge on each side of them. At Jacaguas it was observed that the centering settled under the weight of concrete much more than was anticipated, and after much delay the greater part of this settlement was traced to the sand boxes, some of them going down 1½ ins. or more. The plugs fitted as tightly as would work. Soon after the settlement of the sand boxes was discovered, the contractor directed the foreman in charge of centering to make an experiment. A sand box was packed carefully, the plug inserted, and two men set at work with sledges, the plug was sledged down to about 3 ins., and the foreman reported that he could have sent it to the bottom if he had kept on long enough.

The machinery used in the construction of the bridges consisted of two 6-in. centrifugal pumps, one 3-in. pulsometer, one pump 2-in. suction for raising water, one pile-driver with 2,240-lb. hammer, one pile-driver engine, one Champion stone crusher, and two portable 25-HP. engines for running the pumps and stone crusher.

All concrete was mixed by hand, and deposited in place with wheelbarrows. At Jacaguas, the crusher and mixing platforms were located near the west pier, about 20 ft. below the grade of the roadway, some of the hauls were quite lengthy and on heavy grades, but, everything considered, no cheaper way of handling the material could be found. Broken stone (crushed boulders) was used in all concrete. At Guayo, gravel obtained from the bed of the river near the bridge site was used for all concrete; this, as well as sand, could be delivered at one end of bridge at about the same cost as to the other. Mixing platforms were therefore located at each end of bridge, and for the wheelbarrow work the haul was much shorter and the grades much lighter than at Jacaguas.

All materials used for concrete were tested by the Board of Public Works in San Juan. Alsen's Portland cement was used throughout the work, and the tests made gave satisfactory results. The sand was obtained from banks near the bridge sites, and although it was not as good as could be desired, there was no better within any reasonable hauling distance, or so far as the writer knows on the island. Tests were made on sets of six briquettes, after being kept one day in air and six days in water, giving the following tensile strengths per square inch:

	Lbs. per sq. in.	
	Mean.	Max.
1 cement, 2 Jacaguas sand, 24% sediment..	208	240
1 " 2 Guayo, contains 27% " ..	208	256
1 " 2 Guayo, contains 29% " ..	215	240

Tests made with washed sand gave about 50 lbs. per sq. in. greater strength than with unwashed sand.

The tests on the sand used in the work, washed and unwashed, were not completed until quite a large part of the concrete work at Jacaguas had been done, but all sand was washed thereafter. This was done by shoveling the sand into a trough through which was running a 2-in. stream of water

FIG. 1. CONCRETE-STEEL ARCH BRIDGE OVER JACAGUAS RIVER, PORTO RICO.

FIG. 2. CONCRETE-STEEL BRIDGE OVER GUAYO RIVER, PORTO RICO.

*Park Row Building, New York city.

with sufficient head to carry off the sand and deposit it in a box at the end of the trough, the water containing sediment overflowing the box, and the sand being drawn off at the bottom. Sand screened from the Guayo gravel gave only 6.5% of sediment, the sand screened through a 64-mesh sieve constituting from 16% to 33% of the volume. For the piers and abutments coarse gravel carrying the minimum of sand was used, bank sand being added to give the proper proportions to the mixture. For the arches a finer gravel carrying the proper proportion of sand without the addition of bank sand was used. The broken stone used at Jacaguas was of good quality. Boulders found in the excavations and in the bed of the river, of such size as a man could handle, were used for crushing. The part that would pass through a 1¼-in. ring, including stone dust, was used for the arches, the remainder that would pass through a 2-in. ring was used for all other parts of the work. Tests made by the Board of Public Works on briquettes composed of one part cement, and two parts screenings from the arch stone that would pass through a 64-mesh sieve, seven-day tests, in sets of five, gave the following tensile strengths per square inch:

			Mean.	Max.
With screenings containing		28% dust...	372 lbs.	433 lbs.
"	"	22% " ...	405 "	422 "
"	"	30% " ...	392 "	430 "
"	"	0% " ...	412 "	444 "
"	"	100% " ...	297 "	304 "

The screenings of No. 2, containing 22% of dust, were from stone that had passed through the crusher twice. Tests on five briquettes, composed of 1 part cement and 2 parts of clean standard sand, crushed quartz, gave a mean strength of 321 lbs.; and tests on five briquettes of neat cement gave a mean strength of 558 lbs. It will be seen that mortar made with screenings containing from 22% to 30% of fine stone dust has nearly the same strength as when made with screenings containing no dust, and has 12% greater strength than when clean sharp standard sand is used; also that mortar made with fine stone dust in place of sand, is only about 7% weaker than when made with clean standard sand, and much stronger than when made with any sand to be found in Porto Rico, washed or unwashed. These tests only confirm what has been said by several writers before, that when fine screenings are taken out of crushed rock and replaced by sand, it is to the detriment of the concrete. The crushed rock that passed through a 1¼-in. screen at Jacaguas contained about 20% of screenings that would pass through a 64-mesh sieve, and was classed as sand; sufficient bank sand was added to make the specified mixture.

The cement used on the work was imported from Germany direct; the lumber, piles, steel, machinery and tools were mostly imported from the United States. All material was landed on Ponce Playa and hauled to the Guayo and Jacaguas bridges, eight and ten miles, respectivtly, by ox carts, the only available means of transportation. Every effort was made to hire or buy wagons for hauling the piles, long timbers, and steel bars, but without success. The piles were balanced on a cart and hauled one at a time, the 30-ft. steel bars and long timbers were also hauled at great disadvantage. Mule teams and wagons are used by the army, but cannot be hired, and the natives will not use them, ox carts with yoke attached to the horns being good enough and fast enough for them.

The specifications call for piles 30 ft. long with 10-in. top—a common western specification, but such piles could not be found in or about New York, 6-in. top being the standard. Out of many thousands of piles in the Erie Basin, 112 pieces only were found, which by cutting down from 50-ft. lengths would give from 8 to 9-in. top. As some piles were required promptly, these were accepted by the Board of Public Works and shipped by steamer from New York. The balance of the piles, 10-in. top, as well as most of the lumber, was shipped from Jacksonville. The lumber and piles were contracted for in February to be shipped in 30 days, but owing to the difficulty of the shipper in chartering a schooner, it did not reach its destination until June 5, thereby delaying the work quite materially. The day following the landing of the cargo, the crew of the schooner mutinied, and Capt. Trask was forced to kill one of the sailors; the subsequent proceedings ran up quite a bill of costs which the Mayor of Ponce kindly offered to let the bridge contractor pay.

Native labor was employed throughout, the foremen only being Americans or Europeans. As the natives could not understand a word of English, and the foremen, with but two exceptions, could not talk Spanish, the situation was somewhat trying. The foremen soon learned to swear in both languages. When the foremen of carpenters, for instance, in his best Spanish, sent a man for a saw and he came back fifteen minutes later with a crowbar, no ordinary language appeared to do the subject justice. The laborers as a rule were willing enough to work, but they were barefooted, which was a disadvantage in some kinds of work. They also subsisted on a very slender diet, but have much greater endurance than could be expected under such conditions, in that tropical climate.

The wages of labor are low on the island. The prices paid per day of ten hours by the contractor, which were somewhat higher than paid by the plantations and other employers in the vicinity, were as follows: Common labor 45 cts., concrete men and watchmen 60 cts., carpenters $1.20, masons $1.50, ox carts with driver $1.80. American foremen were paid their expenses to and from the island and wages considerably higher than they had been working for in the United States. Everything considered, the work was done no cheaper than the same class of work can be done in the United States with the prevailing high-priced labor.

The contract prices were $59,438 for the Jacaguas bridge, and $25,683 for the Guayo bridge, a total of $85,121 for both bridges, which were included in one contract. Work was commenced under the Military Government, and completed under the Civil Government of Porto Rico. Geo. W. Davis, Brig.-Gen. U. S. V., Military Governor; W. V. Judson, Capt. Corps of Engineers, U. S. A., President of Board of Public Works; Pedro F. Fernandez, and Juan Rodriguez, members of the Board of Public Works.

On May 1, 1900, the Military Government was superseded by the Civil Government. Hon. Charles H. Allen, Governor; A. Stierle, President of Board of Public Works; Pedro F. Fernandez and Juan Rodriguez, members of Board of Public Works. At this time the foundation work at Jacaguas was well under way, and concreting had been commenced at the west abutment. All officers of both the Military and Civil Governments, including the customs officials, treated the contractor with the utmost courtesy and fairness, from the commencement of the work until its completion, which was not only highly appreciated, but in striking contrast to the treatment accorded Americans in general by the native municipal and legal authorities. The bridges were commenced at a time of great distress; the hurricane of August, 1899, had devastated the island, labor was unemployed, and people were dying of starvation on every hand. The work gave much-needed employment to a large number of men who were treated fairly and paid promptly, and no doubt was the means of saving some lives from starvation. In any American community this would have been appreciated, and the contractor felt that he was entitled to at least fair treatment. He received such treatment from a few of the best and most progressive citizens of Juana Diaz, whom he will hold in grateful remembrance, but the Mayor and City Council went out of their way to annoy him, discredit his work, and injure him in every way possible.

The climate of Porto Rico is very uniform, the temperature, except on the mountains, where it

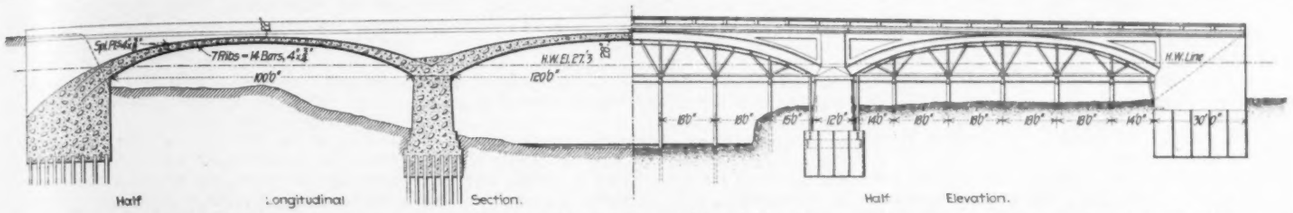

FIG. 3. HALF SIDE ELEVATION AND HALF LONGITUDINAL SECTION OF CONCRETE-STEEL BRIDGE OVER JACAGUAS RIVER, PORTO RICO.
Capt. W. V. Jackson, U. S. Engineers, President Board of Public Works; Edwin Thacher, M. Am. Soc. C. E., Contractor.

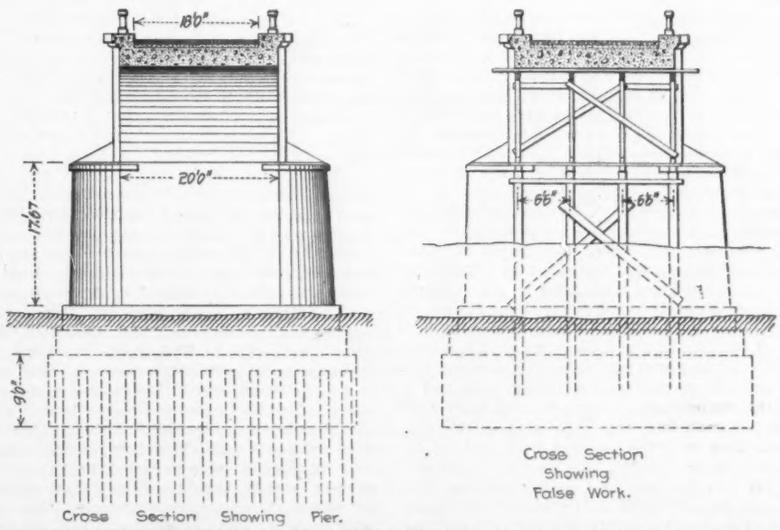

FIG. 4. TRANSVERSE SECTIONS OF CONCRETE-STEEL BRIDGE OVER JACAGUAS RIVER, PORTO RICO.

heavy casings of 12, 10, 8, 6 and 4-in. diameter successively telescoped one in the other; but he still employed the jet in the sand. Boring was commenced in October, 1900; and on Jan. 10, 1901, a layer of rock containing marine shells was reached at a depth of 1,160 ft. For 150 ft. above this the drill had passed through layers of sandstone and concretions of limestone. At this time there were about 600 ft. of 4-in. pipe in the well, weighing at least 6 tons; and this and the casing above was full of water.

When the rock was penetrated the well "blew out," forcing the column of 4-in. pipe out of the well and upward to a height of 300 ft. above the derrick. When the pipe reached this height it twisted and fell, and the remaining 4-in. pipe was then shot through the top of the derrick. The water followed, accompanied by a column of gas, rock fragments and oil. The rate of flow was at first about 250 barrels per hour; and this flow rapidly increased to 500, 1,000 barrels, etc., until on the third day the flow was estimated at at least 3,000 42-gallon barrels of oil per hour, or 75,000 barrels in 24 hours.

It was at once necessary to improvise some means of preventing the waste of oil; and dams were built to hold it; but it was more important to shut off the well. The apparatus by which the difficult job was finally accomplished is shown in the illustration. It was devised by the contractors, Messrs. Hamill Bros. The carriage anchored an 8-in. gate-valve against upward movement; and below the valve was a short nipple with an 8-in. tee attached. As the oil was spouting through a 6-in. pipe, and the main outside casing was 8 ins., the valve, once in position, would permit the oil to still flow with an enlarged diameter. The carriage withstood the impact, as the valve was drawn down by the bolts, and the tee was screwed into the 8-in. casing.

When this had been accomplished—with the oil still flowing freely through the 8-in. valve—the 6-in. horizontal pipe was inserted in the tee; and then, after bracing the 8-in. valve as firmly as possible, this valve was gradually closed, diverting the stream into the horizontal pipe, and thus carrying the oil out of the way. This operation afforded an opportunity for placing strong foundations for an anchorage both for the valves and the casings. Oakum was then packed between the 8-in. and 6-in. casings and a heavy wrought-iron clamp was fastened around the 8-in. pipe by strong set-screws, and this prevented any upward motion in the 6-in. pipe. Finally, on Jan. 19, the 6-in. gate-valve on the horizontal pipe was closed, nearly nine days after the well began to flow. The pressure after shutting down, as found by the gage connected with the tee, was 104 lbs. per sq. in.

As a further precaution against fire, a large iron cylinder was built about the valves, etc., above the ground, and then packed with sand. The object of this was to guard against the danger of any fire in the oil pools communicating with the well. The wisdom of this precaution was shown on March 3, when a fire did occur which destroyed all the workmen's boarding houses, a considerable number of derricks, and about 300,000 barrels of oil, or the entire overflow of the first nine days.

The fragments of oil-rock thrown out were submitted to Prof. Gilbert Van Ingen, of Columbia University. He reports this rock as a compact quartz sandstone; and the shells ejected were clearly Tertiary in origin; but whether Eocene or Miocene, he could not determine. Dr. A. R. Ledoux, of New York, reports upon the Beaumont oil as follows: The specific gravity of the crude oil, at 60° F. (15.5° C.) is 0.925, equivalent to 21.5° Beaume. The distilled sample-distillation beginning at 150 C°., yielded as follows:

	Percentage by volume.	Sp. grav. of the fraction.
150° to 200° C.	6.0	0.851
200° " 250° C.	13.5	0.867
250° " 300° C.	28.0	0.886
300° " 400° C.	50.0	0.914
Residue and loss	2.5	.....

The crude oil contains 2.04% of sulphur. The specific gravities of other well-known crude petroleum oils is given as follows: Pennsylvania, 0.801 to 0.817; Russia (Baku), 0.859 to 0.871; Alsace, 0.907; Lima, Ohio, 0.816 to 0.860. The specific gravity of the Beaumont oil is thus far higher than that of oils which yield notable quantities of illuminants. But some Wyoming oils equal and even exceed the Beaumont oil. Kansas petroleum is quoted by Redwood as showing a gravity of 0.927; and one example of Pico Canon (Cal.) oil also gives 0.927. The Beaumont oil is also very high in sulphur; the other known sulphury oils containing from 0.077% to 0.98%. Tests show that the Beaumont oil does not at all compare with Ohio or Pennsylvania oil in the yield of illuminants.

The conclusions drawn were that the Beaumont oil was very high in sulphur; that it will yield probably nearer 5% than 10% of kerosene, and only limited quantities of a very heavy burning oil. Its chief application will be for fuel purposes.

CHAIN-STEAMER OF THE ROYAL BAVARIAN LINE UPON THE UPPER MAIN RIVER, GERMANY.*

(With two-page plate.)

The increasing importance of inland water-borne traffic in Germany has caused much attention to be paid to this mode of transportation, and the several governments have appropriated considerable sums for improving the conditions. The Bavarian Parliament in 1894 set aside $800,000 for the improvement of the navigable channel of the river Main, between Kitzingen and Aschaffersburg, and $555,400 for chain-ship navigation upon this section. These works are nearly finished, and five state chain-steamers are at present in commission on the Main. Before the work was commenced a committee was appointed by the Bavarian Government to investigate the different methods of chain-ship navigation, and to observe and report especially upon: (1) Winding-drums, as used upon the Main and the Elbe; (2) sprocket-wheel devices, as used upon the Elbe; and (3) electro-magnetic drums, as used upon the Seine near Paris. Following the advice of this committee, choice was made of the sprocket-wheel type of ship, with turbine propellers, such as are manufactured by the Elbe Navigation Co., "Kette," and are in use upon the Elbe.

The determining reasons for this selection were that this construction entails the least wear upon the chain, and no harm results if the chain is twisted, or even in knots. Moreover, the turbines built within the ship's hull make possible a safe and rapid navigation when the chain has been thrown off in relatively shallow water of 2¼ to 2⅞ ft. depth, where neither a screw-propeller nor paddle wheels could be used. Finally, the turbines can be used to assist in steering the vessel when it is running on the chain, which is a very important matter in view of the many sharp windings of the Main.

*Abstracted from an article by Herr Eduard Weiss in "Zeitschrift des Vereines Deutscher Ingenieure."

The chief dimensions of chain-ship No. V., which is herewith illustrated, are as follows:

Length over all	164 ft.
Length on water line	151 "
Extreme width	24.28 "
Midship heighth to upper deck beams	7.88 "
Draft, with 1½ tons coal	1.84 "
Displacement	163 tons

The profile of the boat is peculiar in that it is highest at the middle, and slopes off sharply at the ends, in order that the work lost in raising the chain may be as little as possible. The material of the hull is soft Siemens-Martin steel, which has an ultimate strenth of 51,000 to 61,000 lbs. per sq. in., and gives by fracture an elongation of at least 20% in a length of 7.88 ins. The spacing of the frames varies, being 17 to 23 ins. in the engine and turbine rooms, 23 ins. in the boiler room and cabins, and 20 ins. at the ends of the ship. To every frame is joined a deck-beam, every fourth one being a Z and the remainder angles. The hull and deck are stiffened by two keelsons and longitudinal girders running the entire length of the boat, and firmly bound together by braces. The sides of the hull are strengthened by angles.

The ship is divided by six watertight bulkheads into seven compartments. Near the boiler there are two iron-lined coal bins with a capacity of 530 cu. ft. The thickness of the plates of the hull varies from 0.177 to 0.283 ins. The horizontal and vertical seams are lap joints, the former with one and the latter with two rows of rivets. The deck stringers are of steel plate. At the ends of the ship and under the chainway the same material is used as a deck covering, but the remainder of the deck is constructed of fir planking. Each side of the boat is provided with two wooden sheer-rails. The openings to the turbines under water are protected by iron and wooden fenders. A wooden railing supported on iron posts is placed along the sides of the boat.

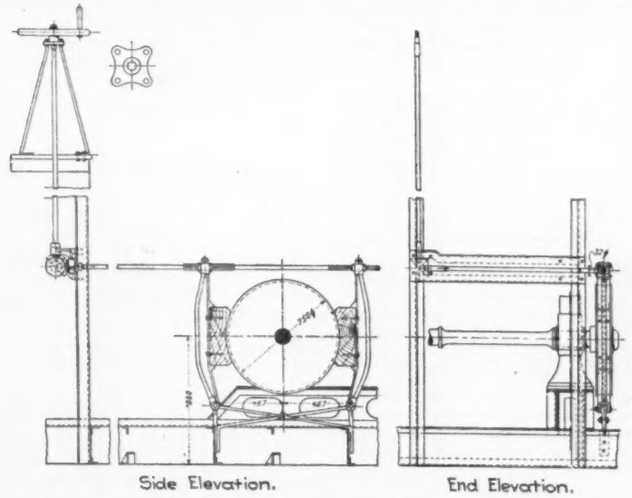

FIG. 6. FRICTION BRAKE UPON CRANK-SHAFT OF WINDING ENGINE.

The steering devices of a chain-steamer are especially worthy of notice. Towing by means of the chain diminishes the steering power, so that two relatively large rudders, 15.4 ft. in length, must be used. One is placed at each end of the boat, and both are controlled from the bridge by means of wheels, longitudinal shafts and chains working upon quadrants, as may be seen in Fig. 2.

The towing chain is led onto the boat by means of cast-steel rollers placed in revolving outriggers at the ends of the boat. It then passes over other rollers placed on separate supports and in the sheet-steel chainway. As the manageability of the boat varies with the length of the forward outrigger, the latter is made 26.1 ft. long, while the rear outrigger is 16.4 ft. in length. Both outriggers are provided with devices for picking up the chain, and that of the forward outrigger may be operated from the pilot deck. The rear outrigger is provided with a windlass, by means of which it may be turned either to one side or the other

is somewhat cooler, ranging from 80° to 95° F. in the shade throughout the year. Light clothing is sufficient for comfort winter or summer, and many children are to be seen on the streets wearing no clothing whatever. When the writer first visited Porto Rico he heard much of the wet and dry seasons; he was informed that the dry season commenced about Dec. 1, and continued until about July 1, July and August being doubtful, and the balance of the year wet. As a matter of fact, he found that violent rains were liable to occur any month in the year, and in some localities every day in the year. One of the greatest difficulties with which a contractor must contend in Porto Rico is the suddenness of changes in the conditions of the weather and the rivers, giving no time for preparation. The writer has left the office under a clear sky for a five-minute walk to the bridge, and been obliged to take shelter from a violent shower before he reached destination, and on one occasion was standing on the bank of the Guayo River, where there was not a drop of water to be seen, the bed of the river having been dry for a month, and within ten minutes the river was too high to ford.

The arch concrete at Jacaguas was laid in three longitudinal sections, the center section having a width of 9 ft. and the outside sections a width of 5.5 ft. each. At Guayo the arches were built in two longitudinal sections of about equal width. On Oct. 16 last the contractor met with a serious misfortune at the Jacaguas bridge which resulted in the loss of the center and south sections of the center arch, and delayed the completion of the bridge fully two months. The contractor assumed all responsibility for the disaster, and replaced the sections as promptly as possible, and without expense to the government. The facts on which the cause of the trouble must be based are as follows: The specifications call for monolithic sections, but at the time these two sections were put in, violent rains were of daily occurrence, and to proceed with the work it became necessary to provide some way by which concreting could be discontinued at any time on short notice. The contractor proposed, and the government engineer in charge approved, depositing the concrete in layers, the layers dividing on the neutral line of the arch, work being suspended at any time by finishing against transverse bulkheads. Parts of three days were consumed in putting in the center section.

The writer is satisfied that the method pursued was bad; the work should not have been attempted in rainy weather. Up to the time of relieving the centering the layers had failed to unite, there being about 1 in. of soft concrete between them; this might and probably would have hardened in time. The frequent rains may have injured the exposed surface of the bottom layer which subsequent grouting failed to restore, and the excessive settlement of the sand boxes previously noted, may have had something to do with the failure of the layers to unite into one solid body; in any event, whatever the cause, they failed to unite. The writer is satisfied further that this cause alone would not have been fatal to the sections, as each half, other conditions being favorable, was sufficient to sustain the load. The immediate cause of the failure was a large mass of bad concrete in the east half of the center section; this extended entirely across the section and had a length of about 20 ft. This mass was discovered before the centering had been greatly relieved, and was first supposed to be a shell, but on investigation with a chisel, the deeper it was entered the worse it got, and as soon as the centering was fully relieved it dropped out, wrecking the center section and subjecting the side sections to an average load of not less than 880 lbs. per sq. ft. in excess of their own weight, or about six times the calculated load. The north section being a monolith of good concrete, sustained this great load without injury, deflecting greatly, but returning to its original position when relieved, offering the strongest possible proof both as to its strength and elasticity. The concrete in the south section was good, at least it contained no large masses of soft concrete, but it was not a monolith, and the layers of which it was composed had not united into one solid body, and although it would probably have safely withstood the load for which it was calculated, it was not in a condition to stand the great weight and shock imposed by the center section and was wrecked with it. The end spans of 100 ft. each, from which the centering had been removed, were after the loss of two sections of the center span left in a very trying position, subjecting them to a test much more severe than they can ever be called upon to sustain again, and which it is believed no stone or purely concrete arch would have stood, but fortunately these spans were not injured. The west span never gave any evidence of having sustained a shock from first to last, but the east span did, and it was feared for some time that this span had been injured, as cracks could be discovered in the soffit west of the center, but it was found by subsequent thorough investigation that these cracks were caused by shells, and did not extend beyond the mortar face.

The writer now believes that the mortar face on the soffit of an arch, or on concrete work in general is bad practice, and that plastering is much worse. The mortar face is almost always mixed in to large batches and gets too far in advance of the concrete backing, frequently drying out or taking initial set, and failing to adhere perfectly to the concrete, causing shells of greater or less extent, which, with the unskilled labor and under the tropical heat of Porto Rico, can hardly be avoided, and which, with the skilled labor, and more moderate temperature of the United States are by no means unknown. Concrete deposited in smooth molds and afterwards floated with mortar only sufficient to fill the pores gave much the best satisfaction when used.

Some soft concrete was discovered in the east span, but no large masses of it; this was removed as far as possible and replaced by good concrete. The west span, which behaved so admirably under extraordinary conditions, was not examined so carefully, but is believed to contain very little, if any, bad concrete. The damage was practically confined to the two sections of the center span; these were replaced with concrete mixed and deposited with great care. They are monoliths, and unquestionably in good condition. Every section of the arches, with the exception of the center section of the west span is now a monolith. This section has never shown any signs of weakness, the layers were not washed by rains, and as the centering was not removed until after two months, the layers have probably firmly united.

It is not customary for a contractor to criticise his own work, neither is it an altogether pleasant undertaking, but it is a fact that considerable soft concrete was found in the Jacaguas bridge, and a large body of it in the center section of the center arch, and the important question is how it came there. The writer did not have direct charge of the work, but he visited the work nearly every day, and supposed he knew about how it was being conducted, so will not undertake to shirk any responsibility that belongs to him. The concreting was in charge of men who had had considerable experience in that kind of work, and the government had two, and sometimes three, inspecting engineers assigned to the work, so there was no lack of supervision, at least so far as numbers were concerned, and the Board of Public Works certainly took every usual precaution to insure good work. The contractor was anxious to do good work, and if there was any shortage of cement in any batch of concrete it was without his knowledge or consent. Although the writer does not know, and will not undertake to explain, why all concrete was not good, he has given the subject careful thought, and will state some facts on which theories may be based. The cement was without doubt of good quality, but like all foreign cements used by the writer, it was lumpy. The lumps were soft and could be easily crushed between the fingers, but hand mixing, and some machine mixers, will not reduce them to the original powder. The mixer used at Topeka would do this, as no vestige of a lump could be found in the mortar or concrete that came from the machine. At Little Rock the continuous mixer used would not remove all of them, and the writer, who was engineer of the work, required the contractor to regrind the cement in a flour mill on the work. At Jacaguas, where all concrete was mixed by hand in batches containing one barrel of cement, the sand was spread on the mixing board, and the cement spread over the sand, the lumps being mashed with a shovel before proceeding further. This may not have been thoroughly done in all cases, as a workman will not do it properly unless constantly watched, and even foremen get careless when urgent demands are made on them for more concrete, so it is quite probable that some of the concrete suffered, not from lack of cement, but from lack of thorough reduction of the lumps and their incorporation in the mortar.

Sand was obtained from pits in the vicinity, and had to be selected with care. The sand used was of very dark color, the color being about the same as the deposit of loam, sand and clay found on the surface, and which had to be removed to reach the sand selected. It is possible that some of this surface material which could not be detected by its color found its way into the sand pile, and was used in the concrete. This appears to the writer as the most probable cause of the large body of bad concrete found in the center section of the center arch. The sand ordinarily used was improved by washing, but some very good concrete was made with unwashed sand. The mixing was probably neither better nor worse than the general run of hand-mixed concrete. The concrete of Guayo was good. It was thoroughly mixed and well rammed, the only exception to this ever discovered was in a contracted space in one of the abutments too narrow to admit an ordinary rammer, and which appeared to have escaped without any ramming at all, but this did not much exceed one cubic foot altogether.

This latter bridge never gave any trouble or uneasiness in any way, and so far as the writer knows, has but one defect, which he hopes to have remedied in due time. It has been stated that this bridge never gave any deflection when the centering was removed, when the test load was applied, or at any other time, in fact it was too stiff. The reason for this is supposed to be that the spandrels combined with the deep solid concrete parapets were stiffer than the arches proper, and this opinion is strengthened by the fact that the spandrels have separated from the arches at center in three places. Many similar cases are on record, but this is the first case on work with which the writer has been connected. It is evident that this does not weaken the bridge, but mars its beauty, and should be considered in design. The moral drawn by the writer from his experience in Porto Rico may be expressed as folfolws: Be sure of your sand. Mix all concrete for important work with a good mixing machine, and build all arch concrete in monoliths having the full depth of the arch, the monoliths being either longitudinal or transverse, it does not matter much which.

THE GREAT OIL WELL NEAR BEAUMONT, TEX.

The history of the great oil well, near Beaumont, Texas, is told by Capt. Anthony F. Lucas in the Transactions of the American Institute of Mining Engineers. Mr. Lucas lives in Beaumont, and he says that certain geological indications, four miles south of Beaumont, led him to test the locality by means of a well. Previous attempts had been made in the same place, in 1894, 1896 and 1898; but they all failed to pierce the 500 ft. of quicksand which underlies the surface soil. At first Mr. Lucas tried the system of boring used by him in the Louisiana salt-deposits. This was the so-called jetting system; in which a 6-in. pipe was forced down by a pile-driver as far as it would go, and the ground below then pierced by a jet from a 2-in. pipe; telescoping the casing from 6 ins. to 2½ ins. diameter. In later pipe-sinking through drift sand in Louisiana, a 4 or 6-in. pipe, with a cutter made by "ragging" the bottom sleeve, was driven downward by a constantly revolving motion; while water is forced through it by a "circulating-pump" connected by a hose with a "wet-swivel" on the top of the pipe. After the men had gained experience, the writer says that he had thus penetrated 400 ft. of drift sand in less than 8 hours.

In the case of the Beaumont oil-well, however, Capt. Lucas found this system inadequate in dealing with quicksand. He, therefore, used large and

water going into the entrance pipe. The elbow (h) of this pipe is hung on the horizontal axis (i) and so shaped that it will connect with the outflow pipe (c) and the return pipe (g). By turning it is lifted from the water and does not interfere with the forward motion of the ship. The elbows can be operated from the deck, either both together or singly. The water from one turbine may thus be directed forwards and that from the other backwards for purposes of steering. Each turbine is driven by a vertical compound engine having the following dimensions: High-pressure cylinder, 7.09 ins.; low-pressure cylinder, 13 ins.; stroke, 9.85 ins. The cranks are 90° apart and the engines are carefully balanced to prevent vertical vibration. The horizontal vibration due to the rotating balancing weights is scarcely perceptible,

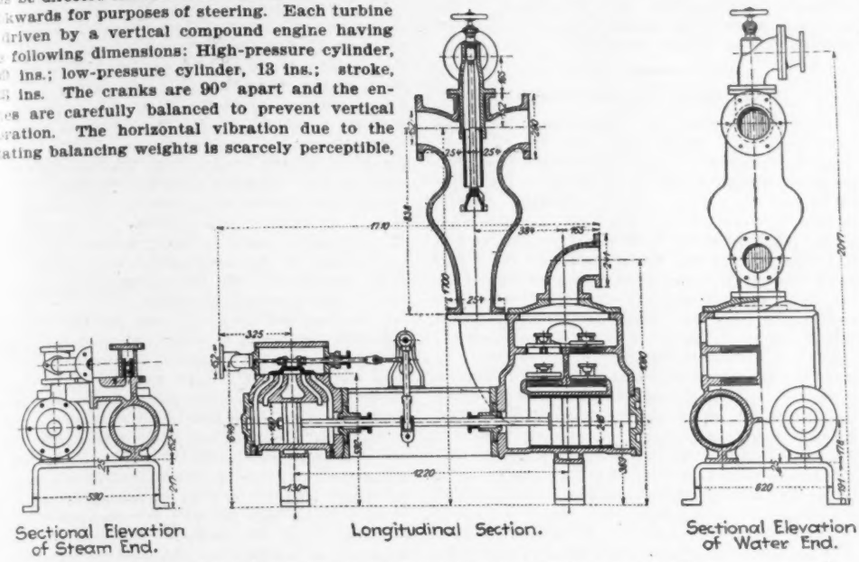

FIG. 9. INJECTOR CONDENSER AND STEAM-DRIVEN AIR-PUMP.

as was to be expected in so broad a ship. The engines work always in the same direction, and are controlled by throttle valves in the engine room.

Although it is customary in river steamers to place the condenser in the immediate neighborhood of the engine, and to drive the air-pump from the crank-shaft or piston rod, an independent plant has been installed in this case which takes the exhaust from all of the engines. The advantage of this is that, since the air-pump is always in action, the engine cylinders are immediately exhausted as soon as the exhaust valve opens, which favors a quick start; also, the engines may be started very slowly and evenly, which is of importance in a chain-steamer. Moreover, a condensing plant common to all of the engines is comparatively simple and saves in weight and attendance. The condenser is of the injector type and is operated by a duplex air-pump furnished by the Worthington Pump Co., of Berlin, and having the following dimensions: Diameter of steam cylinders, 7.47 ins.; diameter of pump cylinders, 8.5 ins.; stroke, 10 ins. An adjustable governor holds the speed of the pump constant. The amount of the injection water is regulated by valve on the condenser for the normal amount of steam and the valve is left in that position.

Steam is generated in a horizontal tubular boiler with internal firebox, and having the following dimensions: Heating surface, 603 sq. ft.; grate area, 19.1 sq. ft.; steam pressure, gage, 150 lbs. per sq. in. The boiler feed water is pumped by a steam pump. It is taken from the waste pipe of the condenser and passed through a pre-heater, which receives steam from the auxiliary machinery. Two injectors are installed, which are connected to take water directly from the river.

In going upstream with the chain the following results are obtained: The steamer can take a tow giving as high as 8,800 lbs. pull in the chain. The corresponding speed is 2½ to 3½ miles per hour. The engine develops 130 HP., cutting off at about ½-stroke in the high-pressure cylinder, and running at 150 to 160 revs. per min. The speed made with the turbines is 7.5 to 8.7 miles per hr. The turbine engines each develop about 65 HP., with 50% cut-off and running at 225 to 250 revs. per min. The condenser maintains a vacuum of 23.6 to 25.6 ins., and the air-pump runs at 32 to 38 double strokes per min.

THE PROPOSED ST. PETERSBURG-WHITE SEA Ship Canal will be 963 Km., or 597 miles long. The canal would be 31 ft. deep and wide enough to admit the largest Russian cruiser, or about 200 ft. wide at the surface. The route would be as follows: From the River Neva, across Lake Ladoga to the River Svir, and down this latter river to Lake Onega; then due north through a dug canal to Seg Lake, and by canal to Vigozero Lake, and thence to the Gulf of Onega and the White Sea. The new canal would create cheap transportation for timber and grain from the provinces of Archangel and Olonets, and be of great strategic value in connecting the Baltic and White Sea on Russian territory.

A NOVEL CABLEWAY is now in use at Beachy Head, England, for carrying stone from the top of the cliff to the new light-house under construction off this point. The site for the new light-house is 350 ft. from the base of Beachy Head cliff, and the top of the cliff is 450 ft. above the sea level. The two carrying cables, about 850 ft. long, are stretched from the top of this cliff to the rock, and blocks of granite weighing 4½ tons, are now sent out by them; the workmen and all material required are thus transported.

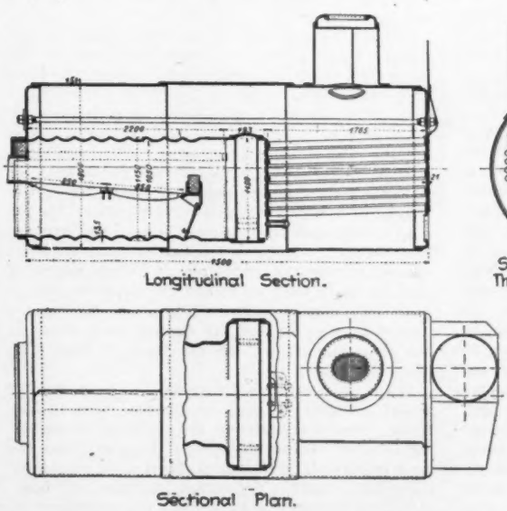

FIG. 10. BOILER WITH INTERNAL FIRE-BOX.

THE LARGEST CHAIN CABLES ever made in this country are being manufactured by the Newhall Chain Forge & Iron Co., with offices at 26 Cortlandt St., New York, for the two large Pacific steamships now being built by the Eastern Shipbuilding Co., at New London, Conn. The chain cables for these enormous freight steamships will be made up as follows: 600 fathoms of 3⅛-in. diameter iron, and 300 fathoms of 1¾-in. diameter iron studlinks. The first is made in "shots" of 15 to 30 fathoms each connected by 3⅛-in. shackles and swivels. Each link of this large cable will be approximately 19½ ins. long and 11½ ins. wide, and will weigh about 100 lbs. to the foot. The total weight of this order will be about 215 tons. The cables will be made in the Lebanon Chain Works, under the direct supervision of Mr. Eli Attwood, formerly of Staffordshire, England, and now President, General Manager and Superintendent of the chain works named.

THE GROWTH OF ELECTRIC RAILWAYS and other street surface roads in the state of New York during the last ten years is shown by their reports to the State Railroad Commission. The following table indicates the increase in their capital stock and funded debt in that time:

	1890.	1900.
Capital stock	$39,213,353	$182,310,412
Funded debt	31,899,714	193,274,738
Totals	$71,113,068	$375,585,150

The corresponding increase for the steam roads during the same period was as follows:

	1890.	1900.
Capital stock	$626,646,512	$807,377,104
Funded debt	605,531,909	802,571,525
Totals	$1,232,178,422	$1,610,128,629

AMERICAN IMPORT TRADE WITH GERMANY now surpasses that of any other country, says U. S. Ambassador White, on July 2, 1901. In 1891 the U. S. imports of Germany amounted to $108,528,000; while those of Great Britain aggregated $160,880,000; Austria-Hungary, $142,324,000, and Russia, $138,040,000. In 1900 these figures changed as follows: United States, $200,750,400; Great Britain $199,920,000; Russia, $173,740,000; Austria, $172,312,000, and France $72,590,000. As regards the export trade of Germany, the United States occupies third place, with $104,482,000. The first place is held by England; the second by Austria-Hungary, and the fourth by Holland.

THE FEAT OF MOVING A STONE HOUSE 20 MILES has been accomplished at the expense of John Stevenson, a millionaire steel manufacturer. Owing to some misunderstanding with the authorities of New Castle, Pa., Mr. Stevenson concluded to move his house, which had cost $100,000, to Sharon, Pa., 20 miles away. A contractor undertook the job for $25,000. The polished hardwood fittings were carefully removed, and then the stone blocks were numbered, taken down and loaded on cars. The house was reerected at Sharon, and the total cost is set down at about $30,000.

THE CHICAGO-LIVERPOOL STEAMSHIP LINE, or Northwestern Steamship Co., is generally decided to be unprofitable, owing to the delays in reaching Montreal by lakes and canal. The President of the company, Mr. Charles Counselman, says it is too early to determine the outcome of the venture. But he admits that insurance companies insist on a rate of $1.25 per $100, as against 15 to 20 cts. from New York to Europe. This $1.40 per ton is in itself a good profit; and as everything else is rated proportionately high, a large part of the profits is eaten up. He also ascribes part of the trouble to the demoralized condition of freight rates on the railways. Return cargoes are a very important factor, and are not so easily obtained as expected. The experiment will be continued for a year and if then deemed unsuccessful, the boats will be put on the lake service in summer and the Atlantic coast trade in winter.

in order to deposit the chain in the proper channel at sharp bends in the river.

The cabins are wainscoted, and various parts about the ship are fitted with polished brass and copper mountings. The doors and stairways are

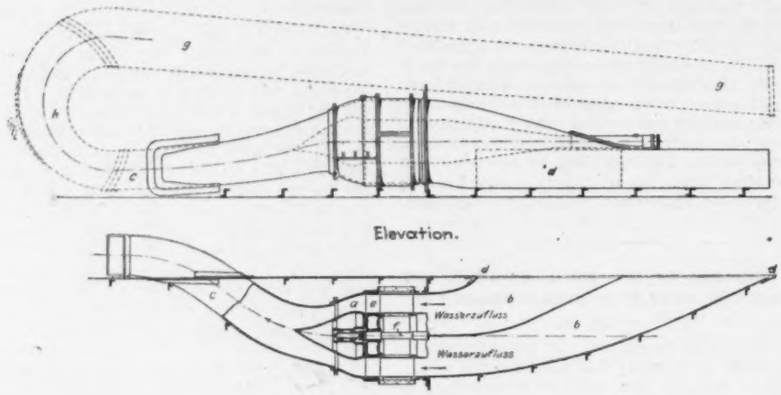

FIG. 7. TURBINE AND REVERSE PIPE.

of oak, and all the cabins are well-lighted by windows and skylights.

Anchor cranes and windlasses are placed both at the bow and stern. Moreover, at the bow is placed a crane to be used especially for picking up the chain while the boat is under way by means of the turbines.

The boat has two independent means of locomotion; going upstream the chain and sprocket wheel are used, and on the downstream course the boat proceeds by means of the turbines. Although a single engine might have been utilized for both purposes, each turbine has been provided with an independent engine, which makes it possible to quickly start up the latter in case the chain should become fouled.

The three engines receive steam from a single boiler, and their exhaust is led to an injector condenser, which, together with the air pump, remains in operation even when all the engines are shut down. As may be seen in Figs. 1 and 2, the middle three compartments of the boat are occupied by the machinery. In the forward compartment is the boiler with its accessories, in the middle compartment are the winding machinery and engines, and the engines for the turbine and condenser plant, and in the third compartment are the turbines and their attachments.

The chain is taken up at the bow by means of the outrigger, with its horizontal and vertical rollers, and guided upon horizontal rollers over the length of the ship, and in a similar manner finally laid down again by the outrigger at the stern. In its course it passes over the sprocket drum of the winding apparatus, the construction of which is shown in Figs. 3 and 4 on the accompanying inset sheet. The chain passes from the chainway under the roller (a), then over the upper part of the drum (b), and finally under the roller (c) to the rear chainway. Since a pressure is exerted upon the roller (a) which is 1¼ times the tension in the chain, and since great fluctuations in the towing force are unavoidable, the tension rod upon which the roller is mounted is provided with a spring. The winding drum, upon the upper part of which the chain is held by fingers, is mounted upon a forged steel shaft which is supported by the cast-steel frame (e) upon both sides of the drum. The frame is attached both to the bottom and to the deck of the vessel. Half-circular sidewalls (f) of cast iron are bolted to the frame on each side of the drum, and are firmly fastened together by stay-bolts and cross-studs, which strengthen the frame and at the same time give access to the drum.

In front of and behind the frame of the winding apparatus are chain boxes (g) and (h), which are lined with hardwood. The forward chamber (g) is provided to enable the boat to proceed downstream with the chain, and the rear chamber provides room for the slack in the chain which occasionally collects at the bends in the river when going upstream. The speed of the rim of the drum, which is, of course, the same as the speed of the vessel, varies between 3.6 and 5.25 ft. per second. The drum is driven by a steam engine geared down in the ratio of ten to one. Cast-steel gears are used upon the chank-shaft (i), upon the drum axle and upon the intermediate shaft (k). Upon the extended crank-shaft is placed a cast-iron brake-wheel (l), against which wooden brake-shoes may be pressed by a screw spindle and levers. The spindle is operated by means of a hand-wheel on the pilot deck. The brake serves to hold the winding machinery fast, enabling the boat to stop anywhere upon the stream without casting anchor.

The engine driving the winding machinery is double, since it must be able to start in any position of the crank-shaft. The principal dimensions of the engine are as follows: Diameter of the high-pressure cylinders, 7.09 ins.; diameter of the low-pressure cylinders, 13 ins.; stroke, 7.75 ins. The cross-head, cylinders and bearings are bolted to two plate girders, which are firmly bolted to the bottom of the ship. The above-named engine parts, which are of cast iron, are so connected by steel truss rods that the body of the ship is called upon to take only the weight of the engines, while the forces due to the thrust of the piston, etc., are taken up internally. The two cranks are placed at an angle of 90°. Weights placed in the balance disk, the brake disk, and the driving gear-wheel serve to counterbalance the reciprocating masses.

The engine is fitted with the Klug valve gear and so arranged that by means of a hand-wheel it may be adjusted for early or late cut-off.

The main steam pipe leading from the boiler to the engine is provided with a valve, which, if necessary, may be used by the pilot to control the operation of the engines. Beyond this valve the steam pipe branches to the two high-pressure steam-chests, and each branch is furnished with a throttle-valve which is under control of the engine driver. Further, a centrifugal governor operates in connection with a falling weight device to close these valves automatically whenever the normal speed is much exceeded. Both low-pressure valve-chests are fitted with valves by means of which steam at full boiler pressure may be admitted to the low-pressure cylinders whenever it is desired to increase the power of the engines.

The turbine propeller is shown in Fig. 7. In order to give the boat sufficient speed and to provide an adequate means of steering it was necessary to install two turbines, one on each side of the boat, as near as possible to the shell of the

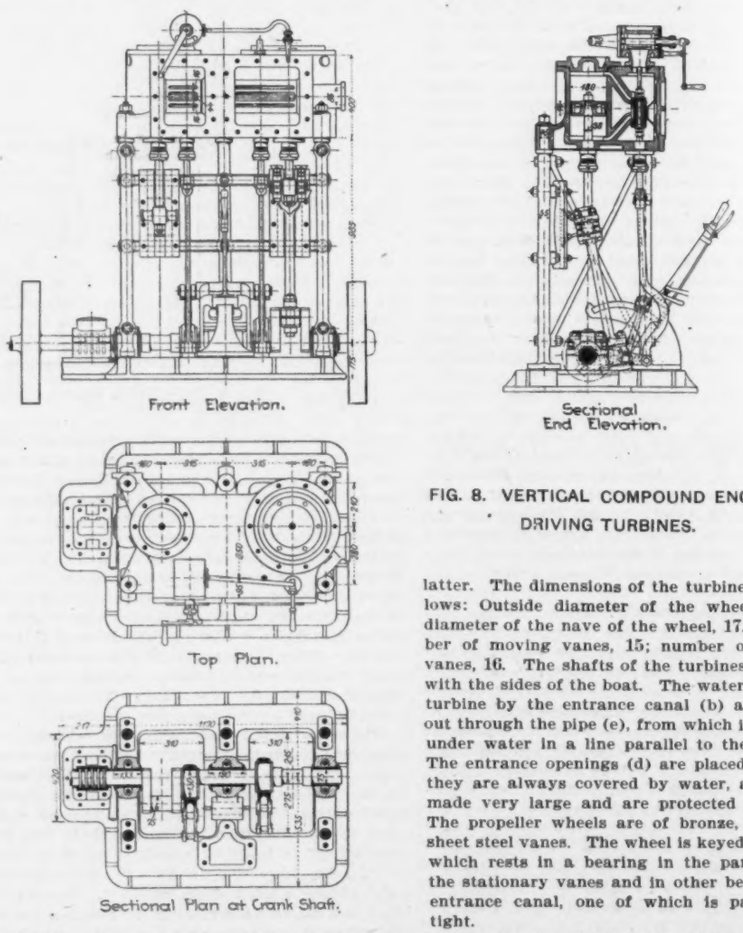

FIG. 8. VERTICAL COMPOUND ENGINES DRIVING TURBINES.

latter. The dimensions of the turbines are as follows: Outside diameter of the wheel, 33.5 ins.; diameter of the nave of the wheel, 17.3 ins.; number of moving vanes, 15; number of stationary vanes, 16. The shafts of the turbines are parallel with the sides of the boat. The water is led to the turbine by the entrance canal (b) and is driven out through the pipe (e), from which it is delivered under water in a line parallel to the ship's keel. The entrance openings (d) are placed so low that they are always covered by water, and they are made very large and are protected by gratings. The propeller wheels are of bronze, with cast-in sheet steel vanes. The wheel is keyed to the shaft, which rests in a bearing in the part containing the stationary vanes and in other bearings in the entrance canal, one of which is packed water-tight.

For steaming backwards sheet-steel reverse tubes are provided, which direct the outflowing water forwards. The forward part of this tube (g) is fixed to the side of the boat, and so placed that the discharged water does not interfere with the

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After having before it for six months the alternative of spending $109,000 to complete the water meter system, or $180,000 for a new force main and accessories, the city council of Norfolk, Va., appears to have dodged the issue by voting to put a meter at each end of the present 24-in. force main, five miles in length, in the hopes of proving that the excessive consumption in Norfolk is not due to the consumers after all. A few years ago the city increased its water supply at considerable expense, and a little later on it put in a mechanical filtration plant. The increase in consumption led the council, last November, to request Mr. W. T. Brooke, City Engineer, of Norfolk, to report on a new force main and pumps, and also on the cost of metering the city. He submitted a report last January, containing the estimates of cost already given. In addition, he stated that if a new main was laid additions to the pumping and purification works would be required soon, at a cost of some $78,000 more. The consumption in Norfolk he placed at 112 gallons per capita, which, since the city has not a large amount of manufacturing, he believed to be largely waste. Here, then, is a city which recently expended a large sum of money for an additional supply, and followed that with the cost of purification works, which, according to Mr. Brooke, is now paying some $7,500 a year for coagulant, alone, and $8,000 a year for coal, and which proposes to encourage and increase water waste instead of cutting it down, or at least making those who waste the water pay for their carelessness. The worst of it is, if we understand the situation, that the city will be at the end of its present supply in a few years, if it continues at its present pace, with no additional source available. A curtailment of waste in other cities has reduced operating expenses and water rates, and thus made it possible for people to introduce city water who thought they could not afford it before, while those who had, say, only a single faucet at the kitchen sink, have been enabled to add a bath tub with little or no extra yearly charge. We see no reason why Norfolk should not have the same experience if it adopts the same common-sense methods. At the same time, the $100,000 or so of water bonds saved might be applied for other sanitary improvements, like extensions of the sewerage system, or more miles of well-paved and thoroughly cleaned streets.

WHAT SHALL FIX FAIR WAGES?

In testifying before the United States Industrial Commission, a short time ago, Mr. Chas. M. Schwab, President of the United States Steel Corporation, remarked that he "believed in the policy of paying labor every cent it is worth." Again, in the "Declaration of Principles" recently made by the National Metal Trades' Association, we find it stated that "a fair day's work deserves a fair day's wage." We take these merely as typical utterances. Similar ones are often heard when the relations of labor and capital are prominently before the public. The point to which we direct attention is that such statements, no matter how sincerely they may be made, accomplish nothing toward defining the true relations between those who work for wages and their employers. Mr. Schwab would pay labor every cent it is worth; but just there lies the question, what is it worth? What shall be the measure of a "fair day's wage," or for that matter, of the "fair day's work," which is to earn it? More than this, who shall apply the measure? The employer, of course, answers that he alone can decide what rate of wages he can afford to pay, and this seems almost self-evident. The worker, however, objects, and demands that he be given a voice in fixing his own compensation and terms of employment; and he is by many persons accounted a very wrong-headed and unreasonable person for such objection.

Why not, it is continually urged, leave these things for free competition to settle? Let the law of supply and demand operate freely, and wages will be kept up on the one hand by the rivalry of competing employers to secure men, and kept down on the other hand by the rivalry of competing workmen to secure employment. That is the way Society should work out its salvation by accepted theories of political economy. Why does it not work that way in real life?

There are many reasons; but the chiefest is that human labor cannot be bought and sold in the same way as wheat and iron and lumber. To have free competition regulate prices in an equitable way, it is essential that buyer and seller shall meet on something like an equal footing. This is not the case in the sale of labor. The employer's position is strong. The individual workman's position is weak. To the employer the hiring or discharge of a man involves almost nothing. To the man it may mean the change between self-support and beggary. The competition between different employers for the purchase of labor, which is counted on to keep up wages, is seldom an actual fact. Even in industries where employers are numerous they do not bid against each other in the open market for the purchase of labor like buyers of wheat.

Again, it makes no difference to the bushel of wheat whether it goes to London or to Hong Kong. But to the laborer, even a small change in his location means often a sacrifice and loss almost impossible to estimate. Most men, especially those with families dependent on them, will hesitate long before changing from one employer to another, even in the same town or city, and far more when a change involves removal to a new location where all sorts of unknown difficulties may await.

While the force of competition is thus weak in helping the workman, it is strong on the side of the employer to keep wages down. No matter what his liberality, he cannot pay wages much above his competitors, or they will underbid him in the market. Under usual business conditions and in most localities and industries, the employer never goes out in search of workmen. Applicants for employment constantly appear at the shop door. What they want is a job, and the rate of wages to a man tramping in search of work is not all-important. This is part of the competition which threatens the men inside the shop door; but another and equally important part is the competition among themselves. The employer is one. His workmen are many. His aim is to make them compete with each other in their work, so that he can get the largest day's work for the smallest wage. This is the principle underlying all system of piecework, premium plans or other methods of paying labor in proportion to the amount of work produced. The workman, on the other hand, not unnaturally objects to competition inside the shop, and to all those methods which involve it. It is by many deemed very strange that workmen should prefer to be placed on a dead level, so that the best workmen earn no more than the poorest. The fact is that they do not prefer this feature. They choose it merely as a lesser evil to them than any form of competition inside the shop which shall make the output of the most skilful the standard of work and the pay which the most straitened will accept, the standard of wages.

It is often and truly said that the piecework or premium plan ought to benefit the workman. That living wages should be paid to the ordinary workman for an ordinary day's work, and the additional output of the especially skilful workman should mean an extra rate of compensation. Such systems have worked and are working with fair satisfaction to both employer and men. It is unfortunately the case, however, that in any industry where free competition prevails, the tendency of all such systems is to an eventual lowering of the wage rate. The employer who gets the most work out of his men for the least money underbids his more liberal competitor, and compels him to lower his wage scale to a like standard. It is this fact that explains the workmen's opposition to the piecework system in all its modifications.

We remarked above that buyer and seller ought to meet on something like an equal footing if free competition is to effect an equitable adjustment between them. The labor union was originally an attempt on the part of the workmen to place themselves on an equality with their employers in settling conditions and terms of employment. As the union grew stronger and more comprehensive, however, the balance was turned the other way, and in not a few trades it became more powerful than the employers. Take, for example, a trade in which practically all the workmen are union men. If a particular employer in this trade would not consent to the terms dictated by the union, a strike was declared. Now the outcome of a strike hinges almost invariably on the question of endurance. Which can stand it the longest, the employer, with his works closed, or the workmen, without their wages? Under union management, the workmen on strike were supported by their brothers who remained at work, and the strikers were thus enabled to hold out indefinitely.

Such organization on the part of workmen compelled similar organization by employers. The great engineers' strike in England, three years ago, was a trial of strength between the Amalgamated Association of Engineers, comprising the union machinists of Great Britain, and the Employers' Federation, an association of machine manufacturers formed to offset the workmen's organization. In such a trial of strength the employers had manifestly the advantage, for by the simultaneous closing of nearly all the machine shops in the country the workmen were prevented from supporting their brethren on strike. The final result was a compromise, in which the employers gained most of the points for which they had contended.

A similar trial of strength between machinists and their employers had just ended in this country, fortunately without any such long contested battle as that from which the industries of England so long suffered. We have just had on hand a trial of strength between a single employer which controls nearly an entire industry, or rather a whole group of industries, and its workmen in certain of these industries.

The issue in this case was not one of wages or conditions of employment. It was merely whether the Steel Trust should permit all its mills to be

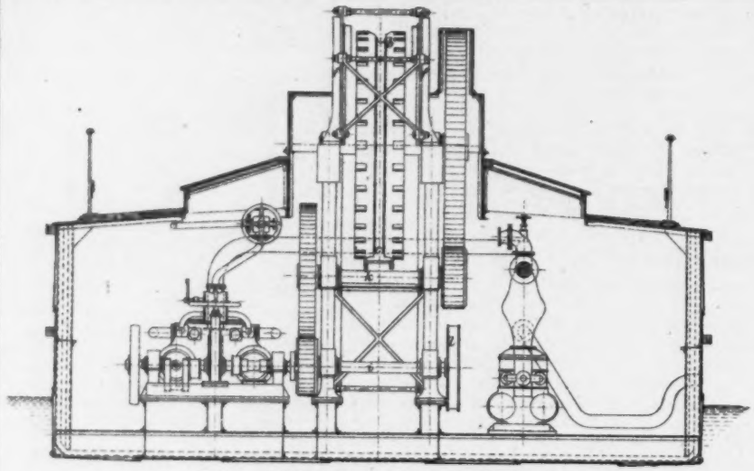
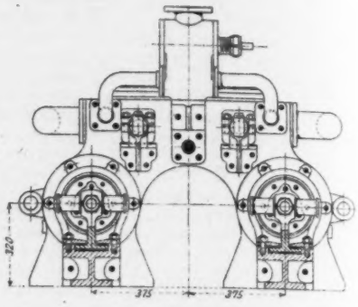
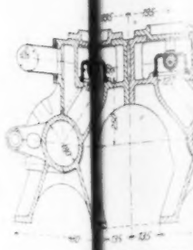


FIG. 4. END ELEVATION OF CHAIN DRUM.



Cross-Section A-B.



Cross-Section C-D

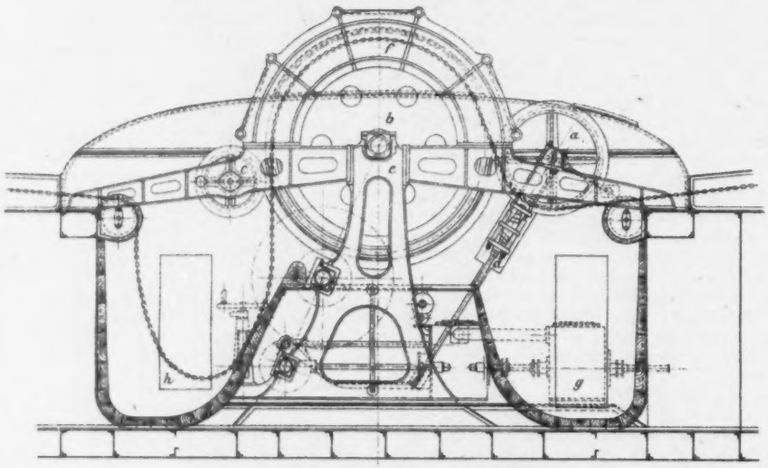
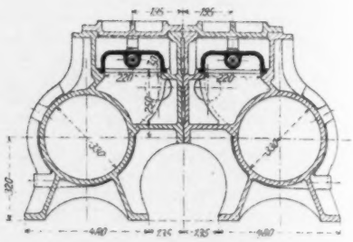


FIG. 3. SIDE ELEVATION OF CHAIN DRUM.



Cross-Section E-F.

FIG. 5.

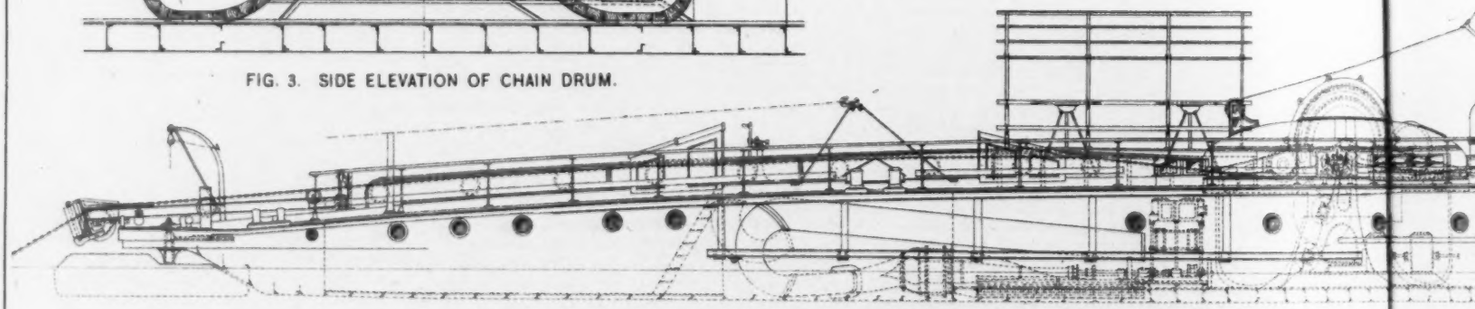


FIG. 1. SIDE ELEVATION

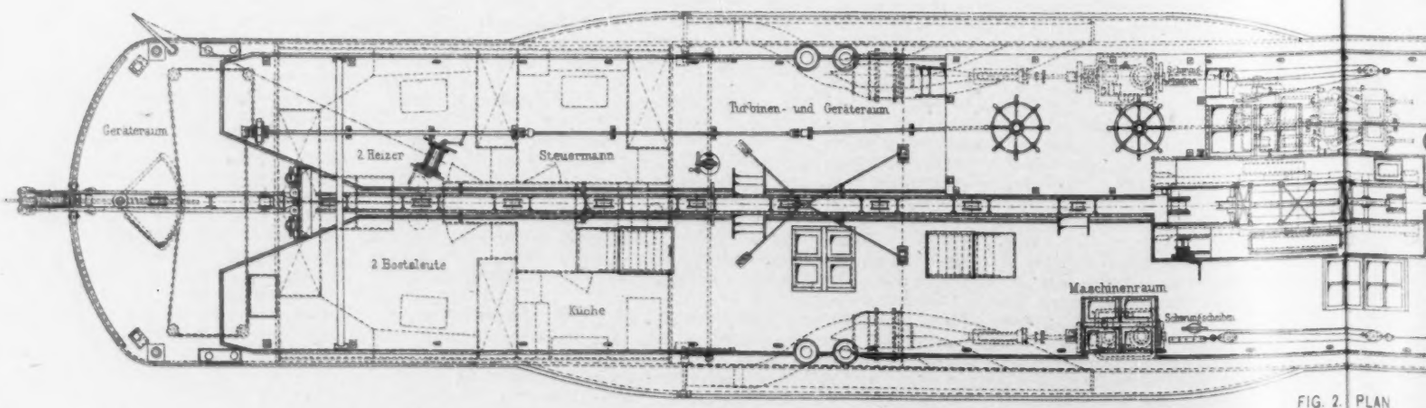
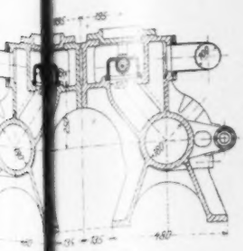


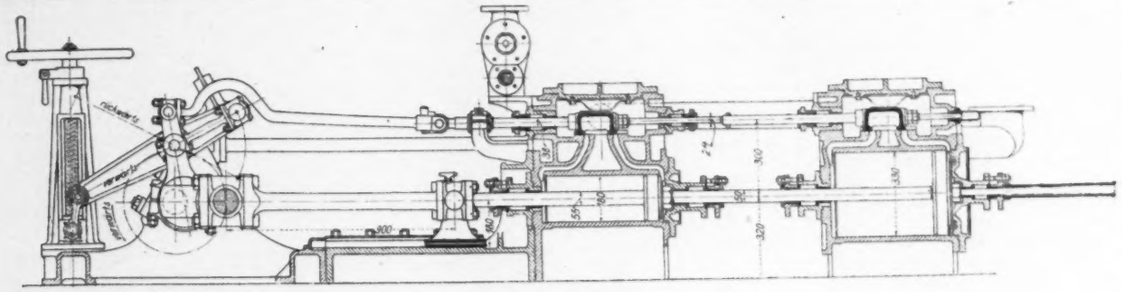
FIG. 2. PLAN

CHAIN-STEAMER ON THE UPPE

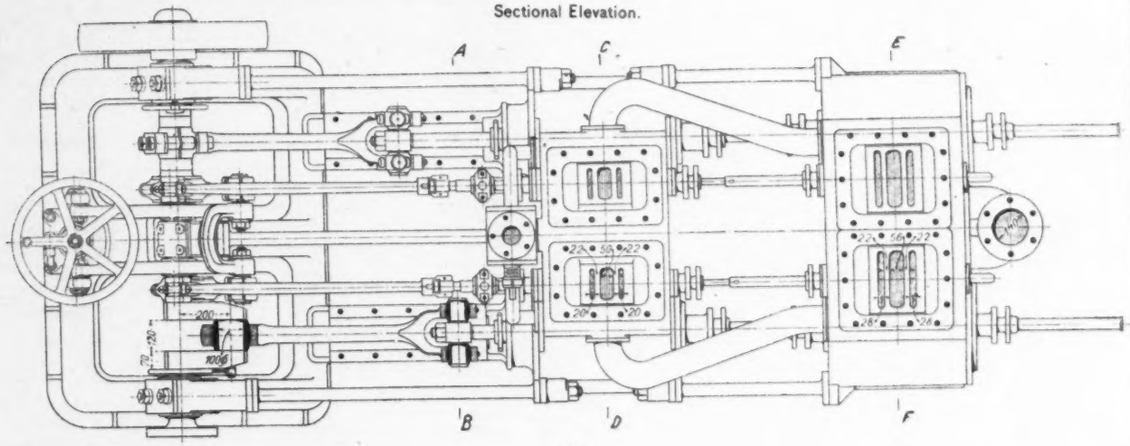
Built by the German-Elbe Navigation Co., "K



Cross-Section C.D.

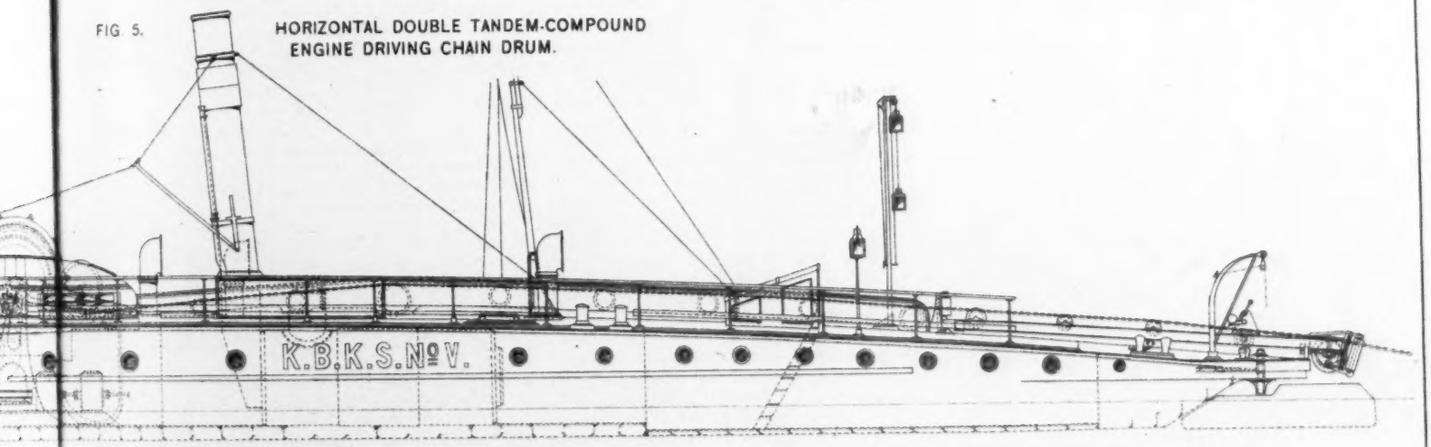


Sectional Elevation.



Plan.

FIG. 5. HORIZONTAL DOUBLE TANDEM-COMPOUND ENGINE DRIVING CHAIN DRUM.



1. SIDE ELEVATION.

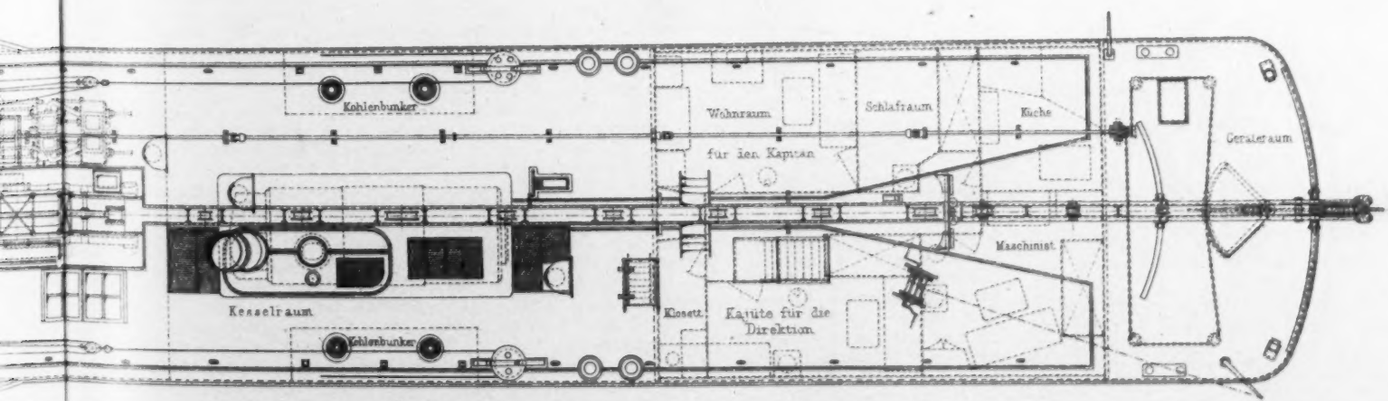


FIG. 2. PLAN

ON THE UPPER MAIN RIVER.

vigation Co., "Kette," of Uebigau, Germany.

CHAS. HART, LITH., 26 VESEY ST., N. Y.

in control of a single labor organization. The workmen declared that since all competition in the purchase of their labor is eliminated, it was only fair that competition in its sale should likewise be wiped out, so that they could deal as a unit with their single employer.

The trust managers, on the other hand, declared that with all their mills unionized, they would be subject to the union's dictation. As matters stood, if the union was exorbitant in its demands, the trust could turn more work over to the non-union mills and close or partially close its union mills. Naturally it desired to maintain this situation, and quite as naturally the union workmen desired to change it. Thus it came about that a whole chain of industries stood idle, and the public which used the products of these industries was put to inconvenience and loss, while the trust and its workmen engaged in a trial of relative endurance.

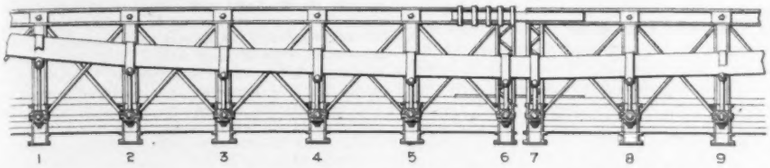


FIG. 1. SKETCH SHOWING LOCATION OF BROKEN SUSPENDER RODS ON BROOKLYN BRIDGE.

And now to recur to our original question—what, under conditions like these, can fix a fair rate of wages? Who is to decide what labor is fairly worth? There is danger to the public in a labor union powerful enough to dictate rates of wages and terms of employment, and which maintains a monopoly of the labor market by restricting the numbers of apprentices and the employment of workmen not members of the union. There is danger, also, in a trust which controls the entire output of a commodity, and can thus fix the price where it pleases, and which has eliminated all competition in the purchase of its labor and other supplies.

The actual fact is that with competition eliminated from our industrial life, we have absolutely no standard for fixing fair wages and fair prices. The workmen in the steel plate mills are as necessary to steel-plate production as the mills themselves. Labor and capital are partners in production, and each is necessary to the other. Apart from competition, however, there is no standard by which their relative equitable shares in the product of their co-operative activity can be determined.

The way to test both wages and prices in any such completely monopolized industry as the steel trade, then, is by comparison with some other industry in which free competition prevails. What are fair wages for the steel workers? They are such wages as are received by workers of similar skill engaed in work of approximately the same general desirability, in industries where free competition prevails.

Similarly, what is a fair return for capital in the steel industry? It is such a return as is received by capital used under a similar risk in freely competitive industries. In so far as the United States Steel Corporation is paying to the holders of its stock and bonds amounts in excess of this standard, in so far is it imposing an unjust and inequitable burden on the public.

We are well aware that this is not a standard which either the workmen or the trust managers are at all likely to accept. It is not to be doubted that each will take all possible advantage of its monopoly—the one to exact the highest possible wages, the other to set the highest scale of prices for steel products. The public which has to buy these products has to bear the burden imposed by both these monopolies, and under present conditions is powerless to protect itself.

Nevertheless, it is fair to point out that neither of these monopolies is an absolute one. Each can check competition up to a certain point; but the higher the barriers that are built against it, the more likely are they to be overtopped. The net result of high wages and trust prices in the steel industry is to offer a more and more tempting prize to new competitors, starting in business, perhaps, with low-priced non-union labor. Exorbitant and unreasonable demands by labor unions have been at the bottom of many of the notable attempts to "down" the unions on the part of employers, not a few of which have been successful.

Although the public is powerless against the exactions of the steel trust and its employees; therefore, the powers of these monopolies are by no means limitless. If they use their powers to oppress the public too far, the operation of natural laws will rob them of much of their return, and means will surely be found to curtail their strength by opening the field of competition to the whole world.

THE ACCIDENT TO THE BROOKLYN BRIDGE.

The breaking of nine of the suspender rods at the center of the northernmost main cable of the New York & Brooklyn Bridge, on July 24, stopped traffic on the north roadway of that structure for about 36 hours until the broken members could be replaced. The general nature of the accident may be readily understood from the accompanying sketch, Fig. 1. This sketch shows in elevation the north main cable and the north stiffening truss, with the connections between them, for a distance on each side of the center of the bridge sufficient to include all the broken members. It will be remembered that the stiffening trusses are fixed at the towers, and have an expansion joint at the center of the main span, as shown by Fig. 1. As will also be seen, the stiffening truss is suspended from the main cable by a suspender rod attached to each floor-beam. These rods are made of mild steel and are 2½ ins. in diameter, and vary in length from 22 ins. at the center of the span to about 12 ft., where their length becomes so great that they are replaced by suspender cables. At the top these rods have an eye, through which passes the pin connecting the rod with the cable band. The floor beams suspended from the rods are about 32 ins. deep, and are lattice girders having double channel top and bottom chords. The chord channels are 6 ins. deep, and are spaced 6 ins. apart back to back. Each suspender rod is connected to the top chord of the floor-beam, as shown by Fig. 2. In this sketch, A, A, are the two channels forming the top chord of the floor-beam. Underneath these channels are riveted two plates, B B, bent as shown to form a journal bearing. The bottom plate is shown in plan by Fig. 3, from which it will be seen that the plates have a rectangular hole through the center. In this rectangular hole sets a steel casting, C; with a cubical body and two trunnions, which are journaled in the bearings formed by the plates B B. Through the center of the cubical body of this casting is a hole of somewhat greater diameter than the suspender rod, and through this hole the suspender rod extends and is held by a washer and nut.

The purpose of the hinged connections for the suspension rods is as follows: Normally the suspender rod would hang vertical, and would be subjected to tensile strain only. Owing, however, to the difference in their mass and make-up, the great main cables, 15¾ ins. in diameter, and the comparatively light trusses carrying the roadways, do not expand and contract equally in a longitudinal direction under the ever-varying changes of temperature. The result of this difference in the rate of expansion is a motion of the bottom end of the suspender rod in the line of the bridge, the rod swinging on the pin at its top as a center. In designing the suspender rods originally they were calculated to hang vertical at a temperature of 55° F., and to adapt themselves to a range of temperature of 120° F. To explain more specifically, the records show that the bridge trusses have a maximum movement due to extremes of temperature of from 10 ins. to 14 ins. This means, taking the smaller figure, that the changes in temperature cause the rods to swing about 5 ins. each side of the vertical. It was to allow for this swing, without bending the rods that the hinged connections were provided. Were this free swing not provided the effect of expansion and contraction would obviously be to bend the rod alternately backward and forward in the line of the bridge.

So much for the construction and intended action of the suspender rods. Attention may now be turned to their actual action, and in this connection the report of Mr. C. C. Martin, M. Am. Soc. C. E., the present Chief Engineer of the New York & Brooklyn Bridge, upon the accident is of particular interest, although it duplicates in part the information already presented. Mr. Martin's report is as follows:

I beg leave to make the following report upon the broken suspender rods and cable bands: Around the cables are placed steel cable bands, which are 5 ins. wide and ½-in. thick. These are placed at a horizontal distance of 7½ ft. apart. Connected to these, near the center of the main span of the bridge, on each cable, are 2½-in. steel suspension rods; all of the other suspenders on the main span are made of steel wire rope 1¾ ins. in diameter.

The object of these suspender rods and ropes is to connect the transverse girders of the floor system of the bridge to the cables, which ultimately carry the weight of the bridge with its load.

On Wednesday afternoon it was discovered that seven of these suspender rods and two cable bands were broken, and traffic on the easterly path of the bridge was suspended. On account of the expansion and contraction of the trusses of the bridge there was a longitudinal maximum movement at the slip joints of about 7 ins., and as this movement takes place in the truss through which the floor beams and the lower end of the suspender rods are attached, and does not occur in the cable to which the upper ends of these rods are attached, the result is that the lower end of the rods move upward and forward as the truss expands or contracts. In order to provide for this a steel trunnion block was introduced into this connection, which permitted a rolling motion without producing a cross strain on the rods. This cast-steel trunnion block was 5¼ ins. deep, the rods passing through them freely, and a nut was placed between the blocks to hold the whole in place. Examination shows that all of the broken rods are broken in these blocks, entirely out of sight, and that until enough of them had broken to allow the cable to lift or the floor to settle sufficient for the broken ends of the rods to come into sight, nothing would be known of the break.

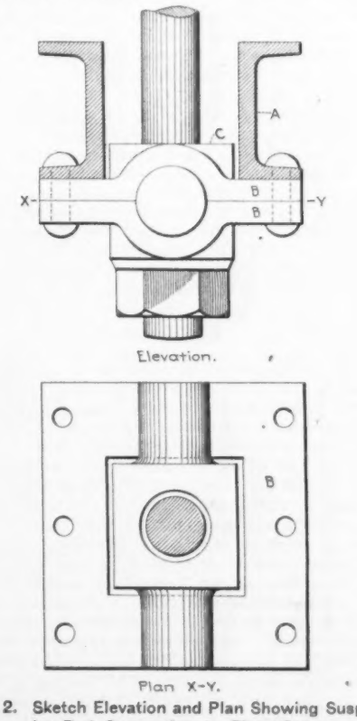


Fig. 2. Sketch Elevation and Plan Showing Suspender Rod Connection to Floor Beam.

An examination of the fracture of two of the rods indicates unmistakably that they have been broken for a long time. All of the remaining suspender rods on this cable and on the other three cables have been carefully re-examined and they are in perfect order. As to the broken cable bands there are 1,700 around the cables on the bridge and it is quite possible that notwithstanding the rigid inspection to which they were subjected before they were put in place that occasionally a defective band may have been used. Constant inspection since the bridge

has been in use has detected a few, and these have been replaced without in any way affecting the strength of the bridge or impeding traffic. In my judgment the cause of the present breaking of several of the suspender rods is as follows: As I have said before, two of the broken rods show old breaks—one much older than the other, as indicated by the broken ends of the rods. One rod having broken would throw additional strain on those adjoining it, and, in course of time, these would give way and the process would quite naturally continue unless the broken rods were replaced.

The fact that the rods on all of the other cables are sound would seem to indicate that my theory is correct, and the fact that one rod in all respects like all of the others broke at all would seem to indicate that it was originally defective.

The suspenders in which the bands were broken were suspenders 1 and 9 in Fig. 1, and the suspenders which showed old fractures were the two nearest the center of the bridge. The initial break is attributed by Mr. Martin to a defect in the rod. It, of course, may have been that there was such a defect, but we think that a brief study of the suspender construction and of the conditions under which they operated will amply account for the accident on other grounds.

Stated briefly, the evidence presented by the broken members was as follows: The two suspenders nearest the center of the bridge had been broken for some time, and one had been broken for a longer time than the other. One of the endmost suspenders showed a clean fresh fracture throughout its full section. All the remaining six rods showed evidence of detailed fracture, that is, only a portion of the entire section showed a clean new break, the other portion being rusted and dirty. It seems evident from this that the cause of the break must have been one which acted continuously and in such a manner as to enlarge gradually an incipient rupture, and, moreover, that it was one which, while it acted similarly on all the rods, had a more intense effect upon the shorter ones nearer the center of the bridge.

It is obvious from what has been said respecting the swinging motion of the suspender rods caused by expansion and contraction, that a movement of from 5 ins. to 7 ins. to one side of the normal vertical position must, since the swinging end of the rod describes a circular arc, exert a lifting effort on the floor-beam. The distance between the hinges of either of the center rods is about 18 ins. If one of these rods be swung 5½ ins. out of plumb the vertical distance between the centers of the two hinges is about ¾-in. less than when the rod hangs plumb. In other words, the tensile strains in each rod alternate between a minimum represented by the vertical load and a maximum represented by a strain resulting from the vertical load and a horizontal force necessary to swing the rod 5½ ins. out of plumb. The change in the catenary of the cable and various other modifying factors need of course to be taken into consideration in any exact calculation of this sort; all that we desire to point out here is that the rods when swung out of plumb by expansion and contraction are subjected to stresses alternating between a minimum at normal temperature and a maximum at the extremes of high and low temperature.

It is furthermore obvious that the strain in any rod will be substantially a pure tensile strain only so long as the hinges act perfectly. Were, for example, the floor-beam hinge to become partially rigid from corrosion, the rod would be subjected to a bending stress alternating from right to left as the truss expanded and contracted. Now, the facts are that the trunnions and their bearings were found to be rusted so much as to render it obvious that they must have operated so hard as to bend the rods each time they swung forward or backward in their pendulum-like vibration. With such alternating flexural strains in continuous action it is evident that it would be only a matter of time when any rod, however good the material of which it was made, would rupture. That several of the rods did fail with a detailed fracture, judging from the appearance of the breaks, seems to lend strong support to the theory that the principal cause of these breaks was the failure of the floor-beam hinges to operate perfectly, thus subjecting the rods to an alternating flexural strain in addition to a severe alternating tensile strain. Had the trunnion bearings been kept carefully lubricated and free from rust the danger of the bending stresses mentioned would have been materially reduced, but this is about all that may be said for the chief trouble undoubtedly lies in the faulty design of the floor-beam hinges. This fact was recognized at the time the designs were prepared, but no way was then seen of remedying it, and in designing the corresponding members for a more recent suspension bridge the same engineer discarded entirely the design he had formerly used on the Brooklyn Bridge, and substituted another which the experience of the intervening years had convinced him to be superior.

A glance at the sketch of the hinge connection to the floor-beam will show that the lower end of each rod sets in a veritable pocket, into which everything can get which is not wanted, and into which it is practically impossible to get the thing most wanted, namely paint. The rods in each case broke inside the trunnion block. A reasonable conclusion is that the greater opportunity for rust at that point was the cause of this. It is also quite possible, however, that the rod in bending was temporarily reinforced by contact with the upper edge of the orifice in the trunnion block so as to bring the maximum bending moment within the block rather than at the upper edge of the orifice. In passing it may be remarked that Mr. Martin's contention that no inspection would show the existence of a break within the trunnion block until enough rods had broken to raise the fractures into sight is hardly sufficient, so far, at least, as any failure to discover the breaks of long standing in the two center rods is concerned. The difference in tension between a rod bearing weight and one hanging loosely is very easily determined by a sharp blow of a hammer.

It does not seem necessary to enter further into the reasons for the accident under discussion than has been done in what precedes. The accident in itself was not serious in its consequences, but it was, it seems to us, serious in the possibilities of a more wholesale failure which it indicated. The facts are that a poor design was adopted for the lower hinge connections of the suspension rods, and that through neglect the evils of this design were augmented by lack of lubrication and by rust. The first fault was perhaps unavoidable at the time the members were designed, but there is no reason why the faulty bearing should not have been kept in the highest possible state of efficiency, particularly since they were fully recognized to be especially in need of care if they were to work satisfactorily. In conclusion, it may be pointed out that it would have been a simple matter at any time during several years past to have replaced these rods with a more approved design of suspender.

LETTERS TO THE EDITOR.

The Advantages of Concrete as Compared With Rubble Masonry.

Sir: The writer while on a visit to several large engineering works in the vicinity of New York has had occasion to observe what seems to him to be obsolete engineering practice, namely, the continued use of rubble masonry laid up in cement mortar. The best engineering practice of to-day condemns the further use of rubble masonry where concrete may with equal advantage be substituted. The experience of the writer has been that in order to secure a fairly representative piece of rubble work, it is absolutely essential to have skillful masons, rigid specifications, and faithful inspection. The consensus of opinion among engineers seems to be that the best concrete work is cheaper than the same class of stone masonry and in addition has the following valuable advantages, which the writer believes should receive more earnest consideration from the engineering profession: Concrete has a wider adaptability; greater convenience of handling necessary materials; it can be built with unskilled labor; it has durability; there is a wider distribution of necessary materials; it is easily combined with various forms of iron and steel; the construction of intricate shapes is easy, and it has superior strength as compared with the same class of stone masonry.

Very truly yours, Walter Seely.

122 Woodycrest Ave., New York city, July 21, 1901.

The Accident to the Brooklyn Bridge.

Sir: It is in order, perhaps, to advance many theories and suggestions as to the causes of the recent breaks on the bridge, and yet I cannot refrain from adding my own opinion, and asking that it may find expression through your columns.

It appears to me that the general suggestions—that heat in the one case, or excessive loading in the other—that both caused the breaks—are warranted by the fa[cts]. The fundamental condition under which they could cause rupture, however, are found in the unequal stresses developed in these supports by reason of their unequal lengths. If, for instance, under a range of 60° of temperature the 50-ft. support should lengthen 0.25-in. and the 5-ft. hangers 0.025-in., the short cables would be carrying a larger share of the load, directly proportionate to the [efficiency] of the stiffening truss and inversely proportionate to the ability of this truss to adapt itself to these conditions.

If then the suspended bridge be subjected to a [live] equally distributed it is readily seen that the greater resilience of the longer suspenders would meet this stress, while the shorter ones would be strained beyond the limit of their resilience. This could not, of course, occur if the suspenders were of equal length, or if their cubical contents (to which their resilience is proportional) were equal. As it is impossible to make them of equal length, and impracticable to equalize their cubical contents, a practical remedy would appear to be found in increasing the areas of the shorter suspenders until they were doubly or trebly as strong as the longest ones. The cable bands and fittings might also be made stronger for the short supports as a matter simply of extra precaution.

This has probably been gone over and provided for, for I am only judging from an inspection in passing, from which it appears that the cable supports are all of equal area—the shorter supports, being of steel rods, are larger in area, but apparently only because the tensile strength of steel rods is less than that of the wire cables.

Yours truly, J. C. Meem.

395 Ocean Ave., Brooklyn, N. Y., July 27, 1901.

The Resistance of Trains on Curves.

Sir: Referring to your editorial of July 18 on the discussion of curve resistance by the New York Railroad Club appearing in same issue, the writer desires to add a word. Your explanation of Professor Lovell's analysis of the action of the forces in a train of cars passing around a curve quite clearly shows why the wheels press the outer rail, but, in the seemingly close analogy to moving a load by means of a rope and pulley, the optical and, for that matter, mental illusion remains. Perhaps it will add a little to the clearness of the demonstration to remember that, in the case of the pulley, the load is all concentrated at one end of the rope and the power at the other, with no intermediate moving weights generating momentums tending to travel in straight lines in opposition to the resultant of the resistance of the load and action of the force moving it. In the train, on the contrary, each car forms a weight unit generating a momentum unit. These units are uniformly distributed around the entire train length, each acting tangent to the curve through its inertia, and radially through its momentum. If the train load was concentrated in the caboose and all the intermediate cars up to the engine were without weight, the wheels would then press the inside rail.

But no one familiar with railway track on curves will fall into the error of assuming that the wheel flanges press the inside rail. It is perfectly obvious from the grinding off on the gage line of the outside rail and the rolling over of a thin lip on the gage line of the inside rail that the wheels run to the outside. This comes near being a case where the "practical man" has the laugh on his theoretical brother.

But the writer wishes particularly to present one point in compensation of maximum grades on curves which he has never seen mentioned or applied, viz.: that the rate of compensation for a given curve should be determined by the relation of the curve length to the maximum train length.

To illustrate, we will assume the train length to be 2,000 ft. and that a grade reduction of .06 per degree for that length of train will just compensate for the resistance of 2,000 ft. of curve length. If this is true, it follows that an equivalent compensation on a curve 1,000 ft. long would be at the rate of .03 per degree. On many long supported maximum grades, the adoption of such a method of compensation would frequently materially reduce a long and deep summit cut or lower the height of a long viaduct at the foot. The above principle of compensation is recognized partially in one way by the adoption of varying rates of reduction per degree on different maximum grades, being less on heavy grades on the basis that, on such, the train length will be shorter. Why not carry the method to its logical conclusion and, having fixed an ample rate of compensation for a given maximum grade rate and train length, vary the compensation per degree in proportion to the various curve lengths in all cases where the latter are shorter than the train length?

To the writer, it does not appear that this question of curve resistance is pertinent to the question of "Increasing the revenue train load by large capacity cars," as discussed by the New York Railroad Club and appearing in your current issue of July 18, except on the assumption that our railway curves are not sufficiently compensated to render their grades equivalent to or less than the maximum on tangents. If the records of the operating

departments of our roads afford any reliable data on the working of the engines as affected by curve compensation on long maximum grades, such information would be of very great value to our constructing engineers.

Very truly, J. L. Campbell, M. Am. Soc. C. E.

Kirksville, Mo., July 22, 1901.

Wood Block Pavement on Beacon St., Boston.

Sir: My attention has been called to an article which appeared in your issue of July 25, 1901, with reference to creo-resinate wooden block pavement which is now being laid by the U. S. Wood Preserving Co., on Beacon St., Boston. In the article in question you state that this piece of pavement is evidently, like the first, an experiment. This does not seem to us to exactly state the facts in the case. The first pavement laid with creo-resinate blocks in Boston was placed on Tremont St. about a year ago, half the width of the street being laid with wood, the other half with asphalt, and gave such excellent results that this year the street department awarded to the U. S. Wood Preserving Co. not only a considerable section on Beacon St., but also sections of Boylston and Newberry Streets, and in addition to these the paving of the Harvard Bridge, connecting Boston with Cambridge, over a mile long and requiring some 12,000 sq. yds. of pavement. Considering the size of these contracts and the character of the streets upon which the pavement is to be laid, it does not seem to us that it is fair either to us or the street department of the city of Boston to speak of these pieces of work as experiments.

In view of the unquestioned superiority of wooden pavement when properly laid in London and Paris, and many other foreign cities, as well as in Indianapolis, in this country, the laying of a properly treated wooden block upon a proper and well-constructed foundation does not really constitute an experiment in any sense of the word, whether said pavement had been previously used in the city in question or not.

It seems strange that the poor results secured with improperly constructed wooden pavements, consisting of round cedar blocks or sappy untreated square blocks, laid on plank or sand, or other improper foundation, should still continue to prejudice many people against wooden pavements, in spite of the fact that their use abroad on the heaviest trafficked streets has given more satisfaction than any other form of pavement used, and that as a result the city of Paris, for instance, has nearly four times as much wooden pavement as it has asphalt. Even had the blocks been properly treated and the wood of proper character, they could not have given good results with the poor character of the foundation used, and in fact, any other form of pavement, no matter how good, would have failed if laid on such foundation.

An additional reason why this pavement should not be considered an experiment lies in the fact that the U. S. Wood Preserving Co. uses a better character of wood than is used abroad, namely, all heart, long leaf yellow pine, instead of Swedish deal, treated with 22 lbs. of creo-resinate to the cu. ft. instead of 8 to 10 lbs. of creosote, as is used abroad. The creo-resinate used is a mixture of 60% creosote, 38% rosin and 2% formaldehyde, this securing a greater amount of creosote per cu. ft. than abroad, held in place by the 38% of rosin, which insures the retention in the wood of a greater amount of antiseptic, and in addition makes the block absolutely waterproof. The use of the rosin also prevents the paving from being slippery.

U. S. Wood Preserving Co.,
F. A. Kummer, Gen. Mgr.

29 Broadway, New York, July 26, 1901.

(We are interested to know that so much wood pavement is being laid in Boston. We did not use the word experimental in a derogatory sense, but merely to indicate our understanding that the pavement in question was being put down in order to permit a comparison to be made between it and the forms of pavement already in regular use in Boston. Our source of information gave no hint as to the extent of the work now being done on Beacon St., and made no reference to the other stretches of the same kind of pavement. The opening part of the last paragraph of the above letter might lead the uninformed to believe that all European wood pavements are of Swedish deal. As many of our readers know, the Australian hardwoods have been used quite extensively in England, of late.—Ed.)

The Hay Steel Process and the First Steel Bridge in America.

Sir: The remarks of Gen. Wm. Sooy Smith on the subject of "Hay Steel," quoted in last week's issue of the News, and the editorial on the same subject, seem to call for some comments by one who was acquainted with the so-called Hay steel process at the time when it was most extensively advertised, viz.: in 1879, the date when the Glasgow bridge was under construction.

In that year I entered the employ of Shoenberger & Co., in Pittsburg, and had an active part in the beginning of their open-hearth steel business, and it was part of my duty to learn all I could concerning all improvements that were proposed in the manufacture of steel. The open-hearth and crucible steel works of Hussey, Howe & Co. immediately adjoined the works of Shoenberger & Co., and I was well acquainted with Mr. Chas. Y. Wheeler, now deceased, who was superintendent of the open-hearth department of Hussey, Howe & Co., and directly in charge of the production of the so-called "Hay steel" for the Glasgow bridge, part of which I believe was melted in the open-hearth furnace under his charge, and the remainder was made in the Bessemer converters at the Edgar Thomson Steel Works.

There was no great secret about its manufacture. Steel was made in the furnace or converter in the ordinary way, and the only difference between the process of its manufacture and that of other steel was the introduction, at or about the time of recarbonization, of a certain quantity of a substance called the "Hay matte," which was said to be made by Mr. A. T. Hay, in Burlington, Iowa, and which was said to have the property of improving the quality of the steel. I have had pieces of the Hay matte in my hand, and I have seen analyses of it in print, but cannot now find them. The substance was simply a slag; it was a mixture of silicates of iron, alumina, manganese and some other substances, and may have contained oxides or silicates of chromium, tungsten or nickel. It was black in color, brittle as glass, and non-metallic. No steel chemist believed then, nor will any believe now, that such a substance added to a steel bath in a converter or in a furnace could have any influence whatever on the character of the steel. It would merely melt and pass into the slag, and under the conditions of the steel-melting process, no part of it would be reduced to the metallic state or alloy with the steel.

I was also acquainted at the time with the inspectors who passed the steel for the Glasgow bridge, and often saw records of physical tests which were made of it. These tests indicated that the steel was no different from any other good open-hearth steel.

Shoenberger & Co. were at that date willing and anxious to do anything and everything that would make their steel the best in the world, and had no hesitation in paying royalties and license fees for the use of processes or apparatus. They were then paying royalties on a dephosphorizing process, and they obtained the first license granted in America for the Thomas and Gilchrist process. If there had been anything in the so-called Hay process they would have known it, and would have been glad to take a license to use it.

Immediately after the Glasgow bridge was erected, steel for bridges began to be called for by engineers, and Shoenberger & Co. did quite a large business in that kind of steels. During the three years that I was with them, I kept the records of the steel furnaces myself, and made many hundreds of tests of their bridge steel, and know that their steel was as good as any open-hearth bridge steel that had then been made in the world. Not a pound of it was Hay steel, or had any relation whatever to the Hay matte. It was simply ordinary acid open-hearth steel, made of stock low enough in phosphorus to meet the specifications, and recarbonized in the ordinary way, with spelgeleisen and ferro-manganese. General Smith says:

> The steel makers stood aloof from Mr. Hay, astonished, although I believe they got all the information they could and applied it and still apply it. The steels now made are more the result of the discoveries of old man Hay than from any other source of information opened to the world. He was, I think, the father of the modern structural steels. . . . I suspect that steel was made clandestinely, by what was called Mr. Hay's process, to avoid the royalties that should have gone to him. . . . Instead of recognizing the merit of it, and that that merit should go to his benefit, I know that it is used by a number of the best steel makers in the world. The very formula used by Mr. Hay is very closely imitated in the best steel that is now made. Hay introduced, as a benefit, aluminum, nickel, chromium, and other metals, relying very largely upon aluminum, and the best steel to-day is made with reliance upon the beneficial effects of such alloys.

It would be difficult to crowd into a paragraph a greater number of errors than the above contains. The steel makers did stand aloof from Mr. Hay, because no metallurgical chemist of that day would give a favorable opinion of his so-called process, and no chemist of reputation from that day to this has ever said a word in its favor. The "process" is not mentioned in either Howe's or Campbell's works on steel. The steel makers have never used the process since 1879. It is not conceivable that if it had any merit it would have died out so quickly. No steel maker uses the Hay matte or the Hay formula to-day, or anything approaching it. Mr. Hay did not use metallic aluminum, as it is now used. In 1879 aluminum was worth over $12 per pound; none was made in this country, and only 284 lbs. were imported. The effect of aluminum on a steel bath was not known until about 1886. (Howe's Metallurgy of Steel, p. 87.) Nickel steel was not known till 1889. Howe says, referring to Riley's paper before the Iron and Steel Institute in 1889:

> Hardly have we begun to recover from our surprise at Hatfield's discoveries as to manganese steel (1888) when J. Riley startles us with his statements concerning a probably more important and but little less remarkable substance, nickel steel.

As for chromium, its value as a steel alloy was known long before 1879, and chrome steel was manufactured in Brooklyn earlier than that date, but Hay had no metallic chromium, or ferro-chromium in his "matte."

"Old Man Hay" is entitled to no credit whatever for any discoveries in the art of steel manufacture. He may have believed that his "matte" had some influence on improving the quality of steel, and he seemed to have convinced General Smith and Hussey, Howe & Co. to that effect in 1879, but I believe Hussey, Howe & Co. never made any more "Hay steel" after that they made for the Glasgow bridge, and I do not think that General Smith built any other bridges with steel made by Mr. Hay's so-called process.

Very truly, William Kent.

New York, N. Y., July 25, 1901.

Notes and Queries.

L. C. Q., Cleveland, O., writes:

> Having given a track on a curve, and having traversed it, can you give me a formula by which I can determine, in the field, regular curves to fit this track?

R. C. M., Tuscaloosa, Ala., writes: Will you kindly furnish me information in regard to relative holding power of round and square drift bolts driven into wood in holes 1-32-in. to 1-16-in. smaller than bolt. Which in your opinion is the better shape for bolts used in ordinary trestle and crib work?

Our correspondent will find abundant information on this subject in Engineering News July-Dec., 1890, p. 488; Jan-June, 1891, p. 199; July-Dec., 1891, p. 283, and Jan.-June, 1894, p. 25. In general, round bolts are to be preferred and the holding power of a 1-in. bolt varies from 6,000 lbs. to 15,000 lbs. per lineal foot, depending on the kind of wood, the relation between diameter of hole and diameter of bolt, and the time after driving before the test is made.

SOLID HYDROGEN was exhibited by Professor Dewar in a recent lecture before the Royal Society, and he announced that a temperature 8 or 10° below this, or 9° from the absolute zero, had been reached. He expects to be able to liquefy helium.

THE IMPROVEMENT OF THE HUDSON RIVER, to provide a 12-ft. channel, says Col. S. M. Mansfield, Engineer Corps, U. S. A., has cost to date $4,746,444, and $1,265,356 are required to complete the project. The portion now under improvement extends from the state dam at Troy, to Coxsackie and the 12-ft. channel is to be 150 ft. wide to Troy, and then 400 ft. wide to Coxsackie.

THE AUSTRIAN CANAL SYSTEM, lately adopted by the government, contemplates the expenditure of over $152,000,000, and 20 years' time, on about 1,000 miles of canal. The purpose of the scheme is to bring the various provinces into closer touch by water communication, and to obtain cheaper freight rates. The project provides for a canal connecting the Rivers Danube and Oder, and the Danube and Moldau, near Budweiss; a canal from the Danube-Oder canal to the upper Elbe, and the improvement of the Elbe to Melnik; a canal from the Danube-Oder to the Vistula and Dniester Rivers, with many smaller projects.

CONCRETE PILE FOUNDATIONS on the Raymond system, described and illustrated in our issue of June 20, are being built for a nine-story apartment house now under construction for Mr. W. J. Bryson on Lake Ave., Chicago, between 49th and 50th Sts. There will be 350 piles, 20 ft. long, with concrete composed of 1 part Portland cement, 2 parts sand and 4 parts stone. As there is to be no basement, and ground-water level has no importance in relation to concrete piles, no excavation is required with the exception of shallow trenches for the concrete beds which will form the foundations for the walls, and in which the heads of the piles are embedded. The material is largely sand and quicksand, and holes are bored by a water-jet system before the steel core with its sheet-iron sheathing is dropped. At first the piles go down easily, but as the sand settles around them they drive hard, owing to the taper, which is much sharper than in wooden piles. As soon as the core is driven to the proper depth it is pulled up, leaving the sheathing in place. The hole is pumped out by a portable hand pump, and then four or five wheelbarrow loads of concrete (mixed quite dry on account of the wet nature of the ground) are thrown in, the concrete being rammed with a tool like a cannon rammer. The concrete is very solid and very hard. The building will be about 144 × 80 ft., and will cost about $250,000. The lower part will be of granite and Bedford stone, while the upper part will be of red pressed brick, with Bedford stone trimmings. Mr. S. S. Beman, of Chicago, is the architect, and the Raymond Concrete Pile Co., 218 La Salle St., Chicago, has the contract for the concrete foundations.

THE MOLDING OF TEST PIECES AND STANDARD SPECIFICATIONS FOR GRAY IRON CASTINGS.*

STANDARD TEST BARS.

Since our last convention there have been made 565 tests, many of which were kindly performed by Mr. H. E. Diller, of Pittsburg, Pa., making the sum total for the complete work 1,601 tests made on 1,229 test bars, not counting the chill pieces and fluidity strips, the whole material handled weighing, roughly, 15 tons. There is considerable detail still remaining in the way of tabulations and critical studies of our series of tests made in all the distinctive classes of cast iron. These matters will be attended to and published from time to time in the "Journal."

Our studies on the shape of the test bar have resulted in the selection of the round form of cross section, and

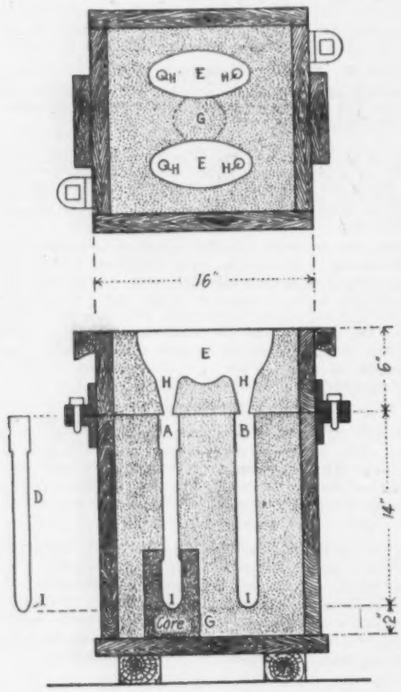


Fig. 1. Plan and Section of Flask and Mold for Casting Cast-Iron Test Bars.

this mainly on the score of greatest uniformity in physical structure, the corners of the square bar introducing elements which become troublesome, especially in irons with a lower range of the silicon contents. It is fully realized that the work of testing bars, especially transversely, is made more difficult by the adoption of the round bar, but after all this should only mean the taking of proper precautions in measuring the actual net deflection; that is, deducting the upper and lower indentations in the bar by the knife edges, as ascertained by micrometer measurement, from the deflection record.

In selecting the test bars for the purpose of specification we have followed the cardinal principle of selecting the largest cross section for the iron consistent with a sound physical structure and within the range and structural limits of an ordinary testing machine. The following are the sizes of bars selected for tests as a result of our investigations:

(1) For all tensile tests a bar turned to 0.8-in. in diameter, corresponding to a cross section of ½ sq. in. Results, therefore, multiplied by two, give the tensile strength of per square inch.

(2) For transverse test of all classes of iron for general comparison, a bar 1½ ins. diameter on supports 12 ins. apart, pressure applied in middle and deflection noted. Similarly for ingot mold, light machinery, stove plate and novelty iron a 1½ ins. diameter bar; that is to say, for irons running from 2% in silicon upward or from 1.75% silicon upward where but little scrap is in the mixture.

(3) For dynamo frame, sash weight, cylinder, heavy machinery, and gun metal iron, similarly a 2-in. diameter bar is recommended; that is, for irons running from 1.50 to 2% in silicon, or where the silicon is lower and the proportion of scrap is rather large.

(4) For roll irons, whether chilled or sand, and car-wheel metals, a 2½-in. diameter bar is recommended; that is, for all irons below 1% silicon, and which may therefore be classed as the chilling irons.

The method of molding the test bars we would recommend is shown by Fig. 1. It will be readily understood by every practical foundryman. Both tensile and transverse bars are shown in the same flask. The elevation shows the tensile bar at A and the transverse one at B. The core C is used with the tensile bar in order to ram it on end. A hole in the floor will save an extra parting if desired. In starting to mold up the bars the dried core is set on the bottom board, and then the pattern as seen at D placed into the hole in the top of the core and let rest on its bottom. Now ram up the bar with green sand in the usual manner. The plan shows four bars. This can be modified as desired. If no tensile bars are wanted, the core is avoided altogether. Two bars may be poured at a time, or four, or more, by simply connecting the pouring basin E E as shown by the dotted line G G, in which case, however, the basin E E should be made much smaller. At least three bars of a kind should be made for a given test. The accompanying sketches give all the necessary dimensions. It will be noted that the bottom of the mold is conical as seen at I. This is to present a sloping surface to the dropping iron and avoids cutting.

These bars could be molded flat and poured on their end by arranging the flask in such a manner that pouring gates and basins can be provided on top. The extra labor to carry out this method would in a measure counterbalance the making of the core C. The only advantage of molding flat lies in the greater certainty of bars free from swells when made by inexperienced molders.

The sand should not be any damper than to mold well and stand the wash of the iron without cutting, blowing or scabbing. It should be rammed evenly to avoid swells, and poured by dropping the metal from the top through gates or from the ladle direct into the open mold. If the sand will not stand pouring from the top, then pour from the bottom by means of whirl gates. If there are more than four bars to be poured from the same ladle of iron, where it would take more than two minutes' time in pouring, they should be gated so that the one pouring basin can fill all the gates at about the same time, thus insuring all bars in a set having the same temperature of pouring. After the bars are cast they should remain in their molds undisturbed until cool.

PROPOSED STANDARD SPECIFICATIONS FOR GRAY IRON CASTINGS.

1. Unless furnace iron, dry sand or loam molding, or subsequent annealing is specified, all gray iron castings are understood to be of cupola metal; mixtures, molds and methods of preparation to be fixed by the founder to secure the results by purchaser.

2. All castings shall be clean, free from flaws, cracks, and excessive shrinkage. They shall conform in other respects to whatever points may be specially agreed upon.

3. When the casting themselves are to be tested to destruction, the number selected from a given lot and the tests they shall be subjected to are made a matter of special agreement between founder and purchaser.

4. Castings made under these specifications, the iron in which is to be tested for its quality, shall be represented by at least three test bars cast from the same heat.

5. These test bars shall be subjected to a transverse breaking test, the load applied at the middle with supports 12 ins. apart. The breaking load and deflection shall be agreed upon specially on placing the contract, and two of these bars shall meet the requirements.*

6. A tensile strength test may be added, in which case at least three bars for this purpose shall be cast with the others in the same mold respectively. The ultimate strength shall also be agreed upon specially before placing the contract, and two of the bars shall meet the requirements.

7. The dimensions of the test bars shall be as given herewith. There is only one size for the tensile bar and three for the transverse. For the light and medium weight castings the 1½-in. D bar is to be used, heavy castings the 2-in. D, and chilling irons the 2½-in. D test bar.

8. Where the chemical composition of the castings is a matter of specification in addition to the physical tests, borings shall be taken from all the test bars made, well mixed, and any required determination, combined carbon and graphite alone excepted, made therefrom.†

9. Reasonable facilities shall be given the inspectors to satisfy themselves that castings are being made in accordance with specifications, and, if possible, tests shall be made at the place of production, prior to shipments.

These somewhat general specifications are doubtless capable of being modified, but are presented by us to this association for discussion and possible approval in lieu of anything better now in existence. The specifications should certainly be fair to consumer and founder, and as experience teaches us better, can be suitably modified from time to time.

*Abstract of a report presented to the American Foundrymen's Association at Buffalo, N. Y., June 4 to 6, by a committee consisting of Thos. D. West, Jas. S. Sterling, Joseph S. Seaman, Joseph S. McDonald, and Richard Moldenke.

*Note.—The remarkably wide range of values for the ultimate strength and modules of rupture which are really good for the various classes of iron, precludes the giving of definite upper limits in the specifications. It will therefore remain a matter of mutual agreement in each case, the requirements of service and price per pound paid regulating the mixtures which can be used.

†Note.—There should really be no necessity for this test, for the requirements of the physical tests presuppose a given chemical composition. It may, however, sometimes be expedient to know the total carbon, silicon, sulphur, manganese, and phosphorus of a casting to insure good-service conditions.

TRANSFERRING GRAIN FROM BOATS TO CARS AT HICKMAN, KY.

To the Transactions of the Engineering Association of the South, Vol. XI., Mr. C. B. Wilson contributes a paper which has special interest in showing one of the methods in use on Western waters for transferring freight from river steamers to the railways.

The grain trade of Hickman, Ky., on the Mississippi River, was an important item to the Nashville, Chattanooga & St. Louis R. R. Co., until an encroachment of the river carried away the first terminal and forced the company to move back to high ground and away from the river. In 1897, the river encroachment having apparently been checked, an effort was made to regain this trade by the use of an inclined track and a wharf boat. But the slope of the bank was such that the steamboat could not be kept close enough to the incline, at all stages of the river, to permit direct loading of cars from the steamers.

In 1899, it was determined to build a grain elevator, to receive freight from steamers by an endless belt incline, instead of a vertical lift. The elevator building was of the usual type; but two inclines were led from the center of the building down to low water in the river. The incline carrying the endless belt starts from the second floor; while the car incline begins at the ground floor. Both the building and the inclines are supported upon cedar piles, penetrating about 18 ft.; and some cribbing was necessary for the lower ends of the inclines.

The machinery consists of an endless roller-chain conveyor on an incline, used to deliver goods from the boat to the second story; two endless roller-chain horizontal conveyors, one running in each direction, from the center of the incline to the ends of the building, and each passing three grain chutes. Two of these latter pass the grain to the cars, and the other passes it to the storage space on the first floor; in addition there is a car incline used for handling any goods that cannot be carried upon the belts.

The main belt incline consists of two parallel rows, or endless belts of roller-chain, made of malleable iron and fitted with 2-in. rollers 6 ins. apart; each roller comprising one link of the chain. These pass over a 24-in. sprocket wheel, at the top of the incline, and this wheel is driven from the line shaft. At the bottom of the incline is an adjustable idler which holds the chain in proper tension. To these rollers are fastened oak slats, 1 × 5 × 5 ins., secured by carriage bolts; one slat to each link, directly over the roller. The incline carrying this belt is on a grade of 28.37 to 100, and consists of two rows of piling, 5 ft. 3 ins. apart in the clear, on which rest 8 × 12-in. string-

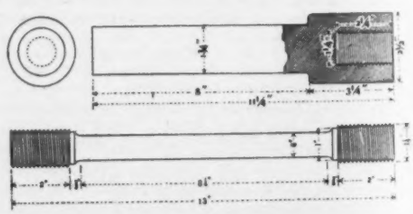


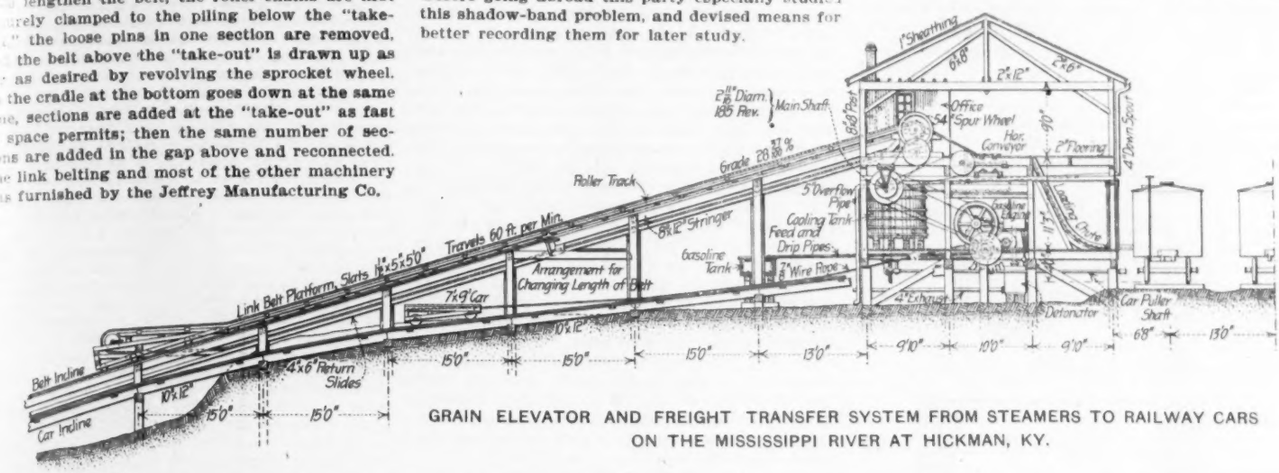
Fig. 2. Standard Test Bar and Steel Socket for Tensile Tests of Cast Iron.

ers carrying a light rail. On this rail rests the supporting track, made of two timbers, 3 × 4 ins. by 5 ft. long, covered with strips of sheet iron, on which the chain-rollers run. These sticks are carried by two 4 × 4-in. ties 6 ft. 7 ins. long, which are fitted with two small cast-iron shoes near the ends resting upon the rail mentioned. As the lower, or downward-bound slats are inverted, this lower half of the belt rests on the lower return slide pieces, which are merely 4 × 6-in. stringers supported by 2 × 8-in. ties spiked to the piles.

As it is necessary to adjust this belt to fit various stages of the river, the roller-chain is made in 5-in. sections by the use of loose pins in every tenth roller. To adjust the length of the supporting track was more difficult; but this process was as follows: When the belt is to be shortened, two long hooks with swivels, allowing 5 ft.

ply, are placed on the belt; the pins were then removed and a 5-ft. section of chain drawn out. The hinged rail, shown in the drawing, was then lowered, and with it a 5-ft. section of track, which is taken out and the hinged rail raised in place again. The chain and track are then both drawn together by the swivels; and the chain reconnected. For the operation repeated, as desired.

To lengthen the belt, the roller-chains are first securely clamped to the piling below the "take-out;" the loose pins in one section are removed, and the belt above the "take-out" is drawn up as far as desired by revolving the sprocket wheel. As the cradle at the bottom goes down at the same time, sections are added at the "take-out" as fast as space permits; then the same number of sections are added in the gap above and reconnected. The link belting and most of the other machinery was furnished by the Jeffrey Manufacturing Co.



GRAIN ELEVATOR AND FREIGHT TRANSFER SYSTEM FROM STEAMERS TO RAILWAY CARS ON THE MISSISSIPPI RIVER AT HICKMAN, KY.

The car incline consists of a stringer track on the capped bents of two piles each; the bents being 15 ft. c. to c. This is equipped with a 7 × 9 ft. platform car drawn by a ⅞-in. wire rope winding on a 24-in. drum. The speed is 180 ft. per minute, and the car is equipped with a powerful friction brake.

Power for the whole plant is furnished by a 34-HP. gasoline engine. This can be started up promptly whenever a steamer blows for a landing and costs nothing for fuel when not running. A 1,600-gallon cooling tank supplied with rain water from the roof furnishes the engine with cooling water.

In unloading sacks of corn from a steamer, the steamer gang throws the sacks on the belt, over the cradle; and as the belt moves 60 ft. per minute it easily takes them away as fast as deposited. As the sacks pass over the sprocket wheel they fall on a chute that passes them to the horizontal conveyors, which also travel 60 ft. per minute. The grain thus passes to the cars, or to storage bins as desired. This elevator can pass 1,000 sacks per hour from boats into cars; or store from 1,200 to 1,400 sacks per hour in the elevator. The largest lot of corn actually handled at one time was 5,634 sacks in six hours. The estimated cost of loading one car with 250 sacks is $1.00; from the time the corn is placed on the belt until the car is filled. To store in the elevator costs 70 cts. per car-load of 250 sacks.

To weigh before loading, small platform scales are set near the top of the chute, and then 8 or ten sacks are placed and weighed as they arrive This work adds about $1.00 per car to the cost, which the shipper must pay. To load corn from storage costs practically the same as from the belt. The only serious difficulty so far encountered is damage to the inclines in landing the boats. To obviate this it is proposed to drive piles on each side of the belt and lay on them a heavy fender, about 12 ins. above the belt. The credit for the plans is due to the Chief Engineer of the railway mentioned; the work of construction was in charge of the writer of the article, mentioned above.

PHOTOGRAPHING THE SHADOW BANDS DURING THE ECLIPSE OBSERVATIONS IN SUMATRA.

The scientific party sent out to Sumatra by the Massachusetts Institute of Technology has made a definite addition to astronomical knowledge by successfully photographing for the first time the mysterious shadow bands which have long puzzled astronomers in connection with the sun's eclipse. All that is known at present—from the brief despatches, is that some of the plates have been developed sufficiently to indicate that photographs of real value have been secured.

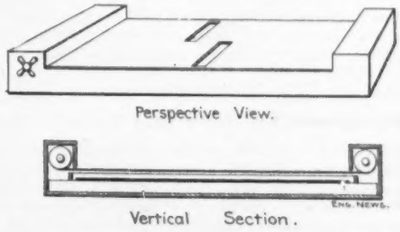
Prof. Alfred E. Burton, who is in charge of the Sumatra expedition, has associated with him Mr. George L. Hosmer, of the Engineering Department; Mr. Harrison W. Smith, of the Department of Physics; and Mr. G. H. Matthes, a graduate of the Institute, now in the U. S. Geological Survey. Before going abroad this party especially studied this shadow-band problem, and devised means for better recording them for later study.

Heretofore these bands have only been observed visually. The quivering bands of light and shade were noted upon the walls of buildings or on the white sand; and the first attempts at record were made by spreading a sheet on the ground, upon which sticks were placed to show the direction of the shadows, and their movements. A slight advance upon this method was the use of long strips of canvas marked with black lines, to facilitate visual measurement of the bands. Sticks painted in alternate colors have also been employed; while an assistant sometimes ran with the shadows, so as to furnish a comparative standard for estimating their velocity. Methods of this kind were used by Prof. William H. Pickering, in observing, at Grenada, Spain, the eclipse of Aug. 29, 1896.

But as these attempts at record are manifestly crude, all theories regarding these shadows, based upon them, are more or less speculative. Prof. Pickering reported that some of the bands were 6 ft. long and some of unknown length; that some moved at the rate of only 6 miles per hour, and others at the rate of an express train; and some moved in an undulating fashion with the speed of a gale of wind. The only theory that he could advance was—That the bands were caused by some refraction of the atmosphere, resulting in visible differences in the distribution of light; and that they were comparable to the familiar phenomenon of hot air rising from a stove on a cold day. He did not believe—as suggested, that they were due to the shadow of the edge of the moon, as he computed that this shadow would travel at the rate of one mile per second, and would be consequently invisible. He assumed that shadow bands fell on the earth from every twinkling star, and from every flickering gas-light; but these were too faint to be seen. To demonstrate his theory, Prof. Pickering, by means of a powerful searchlight located three-quarters of a mile away, produced artificial shadow bands on the observatory wall at Cambridge; which he described as similar in effect to sunlight shining upon distant water ruffled by a light breeze, and as apparently having the same velocity as the wind blowing at the time.

During the eclipse of Jan. 1, 1889, Mr. Winslow Upton observed at Willows, Cal., shadow bands an inch in width and three or four inches apart, and apparently stationary; but an endeavor to photograph them in the ordinary way proved a failure, although the conditions were unusually favorable to the attempt. In recent eclipses long dark bands separated by light spaces have been seen, more or less distinctly, moving rapidly on the ground or on sides of buildings just before and after totality, but even at the eclipse of May 28, 1900, which was observed by practically the same party which is now in Sumatra, they were noted only visually, and no photographic results were reported, owing, it would seem, to the fact that photographic effort was then directed to the reproduction of the appearance of the bands upon a screen.

The method which Prof. Burton has doubtless employed in Sumatra—the method, that is, which was planned by Mr. Harrison W. Smith before leaving Boston—is precisely opposite in its principle to the old method. The new plan is actually to expose a sensitive photographic plate to the bands themselves—letting the bands fall upon it; that is—in place of endeavoring to photograph the bands as they appear upon a screen. It was proposed to use a shutter of the form of the Thornton-Pickard focal plane shutter. In the preliminary experiments two ordinary curtain rollers were fixed at the end of a light wooden frame with an opaque curtain stretched over the rollers to be rolled up on one roller, and when released wound up rapidly on the other by means of a spring. This curtain contained a slot and was stretched directly above a sensitive plate. When the curtain was released, therefore, the slot was drawn rapidly across the plate, which was then exposed to whatever light happened to be falling on the apparatus. If the intensity of the light in Sumatra varied sufficiently from point to point to produce visible bands, it would appear that the bands ought to be recorded by this apparatus on the plate. Again, by having two slots in the curtain, one traveling across the plate just after the other, the velocity of the bands could be determined, the speed of the shutter being known, since the bands on the opposite halves of the plate would not join, but would appear displaced relatively to their velocity and that of the moving curtain.



Apparatus for Photographing Shadow Bands Used in Sumatra by the Observers from the Massachusetts Institute of Technology.

Two sets of apparatus placed at an angle of 90° would record the bands whatever their direction might be; and if the records obtained in Sumatra are as intelligible as the plan of the apparatus would presume, astronomers will have for the first time in history accurate data for scientific study of this particularly puzzling phenomenon. Quite naturally, therefore, they are looking with particular interest for the detailed result of this first step toward an adequate explanation.

THE USE OF SODA IN LAYING MASONRY IN WINTER.

In an article on the building of the railway from Toul to Pont Saint-Vincent, in France, contributed to the "Revue Generale des Chemins de Fer" by M. Descubes, we find a reference to the use of carbonate of soda to facilitate the laying of masonry in cold weather. Experiments were made as long ago as 1890; and mortar thus treated was employed in laying stone with the temperature as low as — 10° C., or 14° F.; and the masonry was later found to be in first-class condition in all respects.

The method adopted is simple; and practically consists in using for the making of the mortar, lukewarm water in which carbonate of soda has been dissolved. While crystalized carbonate of soda can be used, it is more economical to employ

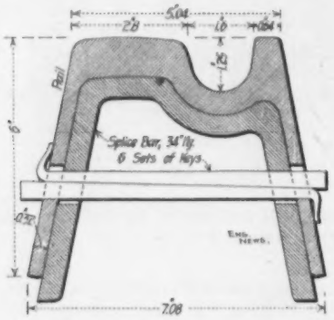


Fig. 1. Cross-Section of Demerbe Rail at Joint; Buda-Pesth Street Railways.

the anhydrous carbonate of soda, as made by the Solvay process, which now costs in France about 13 francs for 100 kilos., or not quite 1¼ cts. per pound.

The dosage used is 1 kg. of anhydrous carbonate of soda to 12 liters of water, or about 0.7-lb to one U. S. gallon of water; with intense cold the amount of water is reduced to one-half, or 6 liters. In the west of France, where the cold is less severe, the author has successfully used 1 kg. of soda to 20 liters of water, or 0.42-lb. of soda to 1 U. S. gallon of water. As to the expense, the writer finds that the cost of one cubic meter, or 1.3 cu. yds., is increased 24 cts. by reason of the addition of the soda; and a cubic meter of beton is increased about 40 cts. in cost. While this additional expense must be considered, it is offset in many cases by the possibility of thus laying good masonry in cold weather. In 1890, and on urgent work, the author thus used 27,000 kg. of carbonate of soda, with excellent results, and a great gain in general economy and precious time.

THE DEMERBE RAIL FOR STREET RAILWAY TRACK.

According to one of the German engineering papers, some English street railways are about to use the old Demerbe type of rail and track, which dispenses with the use of crossties, chairs or separate longitudinal supports. The rail is of inverted trough section, with grooved head and flaring sides, and is not unlike the old Lewis & Fowler (American) and Barker (English) rails, except that they had vertical sides. Unlike these, however, the Demerbe rail is not supported on metal chairs. It is in fact an adaptation to street railway track of the old Barlow self-supporting railway rail which was used in England in the early days of railways, and was simply laid in the ballast and well-tamped. In a report on street railway track prepared by Mr. Fischer-Dick, Chief Engineer of the Berlin (Germany) street railways, and presented at the meeting of the International Tramways Union in 1894, it was stated that the Demerbe rail had rendered good service under horse traction, but that girder rails (either of the Phoenix solid type or the Haarmann built-up type) were preferable for mechanical traction. The Demerbe trough rail is now very little used.

The Demerbe rail has been used at Brussels, Aix-la-Chapelle, Frankfort, Cologne, and Buda-Pesth. Fig. 1 is a cross-section of the Buda-Pesth heavy rail, a lighter section being 3.76 ins. wide on top, 5.6 ins. on the bottom and 5.08 ins. high. This lighter rail was introduced in 1885 as an experiment, and afterwards replaced with the heavier rail. The splice is a trough-shaped bar 34 ins. long, rolled to fit the interior of the rail and secured by six sets of wedges or keys, the smaller ends of which are bent to bear against the webs of the rail. Flat tie-bars, 6.56 ft. apart, serve to maintain the gage, as shown in Fig. 2, the rail webs fitting into notches in the bar and being secured by keys. Up to 1893, no cracks had occurred in the rails or at the holes for the keys, and the rail ends were in good condition, while in 1890 the light rails showed little signs of wear after five years' service under horse cars. The rail fitted well into the paving, and the paving blocks next the rails were not cut to fit them.

At Frankfort, the Demerbe system was in use from 1878 to 1884, but was then superseded by the Haarmann girder rail construction. The joints of the Demerbe rails did not keep in good condition, as the water which entered tended to wash out the filling and leave the ends non-supported. At Cologne, this system was introduced in 1879, but the Haarmann and Phoenix rails have been used since 1886. The narrow guard side of the groove was found to wear more rapidly than the head. The bolted splices originally used proved unsatisfactory, and a different method of splicing was adopted. The key attachments of the tie bars also failed to prevent widening of the gage.

According to the "Centralblatt der Bauverwaltung," a stretch of the Demerbe rail was laid together with ordinary flange rail as an experiment in Leeds St., Bradford, England, in 1894. Both structures rested upon the concrete foundation of the street surface, which is so common in England. While the flange rail was simply laid upon the concrete bed, the Demerbe rail was filled with concrete, which was made of four parts of unsifted crushed granite and one part of Portland cement. In this way it was firmly attached to the foundation.

In September, 1900, one of these rails was taken up. It could be loosened from the concrete only by repeated strokes of a sledge, and even then part of the concrete remained in the rail. The rails and fastenings were found to be absolutely unimpaired, although no outlay had been made for repairs on the Demerbe rail, while the nearby flange rails had been repeatedly repaired.

The paving stones rested firmly against the inclined side of the rail and were supported by the latter. These stones were neither raised nor sunken, although both conditions were found along the flange rails.

In Bradford there are about 44 miles of street railway, of which 40 miles are of flange rail weighing 90 lbs. per yd., and provided with fish-plates weighing 78 lbs. per pair, while the 4 miles of Demerbe rails weigh 60 lbs. per yd. and are provided with connecting plates weighing 50 lbs. each. The weight of the Demerbe rail is, then, about 67% of that of the flange rail. About eleven miles more of the Demerbe rail have been built up to this date. The cost of the Demerbe rail was about 84% of that of the ordinary rail in the above case.

The flange rails on Leeds St., in Bradford, are about to be removed after 16 years of service. The authorities believe from the above experiment that the Demerbe rail will last 20 years, and that during that time it will need no repairs.

The advantages claimed for the Demerbe rail are summed up as follows:

(1) The structure is simple and of few parts.

(2) The rails and foundation withstand the heaviest loads without bending or moving.

(3) The cost of maintenance is very low.

(4) The fastenings are without bolts or nuts, so that no boring or punching is necessary at the place of construction. Also, the tie-bars can be attached by means of a key at any place on the rail.

(5) Curves of short radius are made at the rolling mills, so curved rails can be laid as easily as straight ones.

(6) The concrete bed upon which the rails rest prevents water from getting under the rail.

BOOK REVIEWS.

THE MINERAL INDUSTRY.—Its Statistics, Technology and Trade in the United States and other countries to the end of 1900. Founded and edited by Richard P. Rothwell, Late Editor of the "Engineering and Mining Journal," etc., completed by Joseph Struthers, Ph. D., Columbia University, New York. Vol. IX. New York and London: The Scientific Publishing Co. Cloth, 6 × 9¼ ins.; pp. 918. $5.

The ninth yearly issue of this statistical history of the mineral industry of the world differs little from the preceding volumes in its general subject matter and arrangement. But it records an unprecedened advance in the value of the mineral and metal output of the United States, the aggregate value of which, in 1900, was $1,365,[illegible]3, a gain of $147,393,946 over that of 1899. Of this value for 1900, ores and minerals contributed $672,[illegible]6; metals, $524,432,533; secondary products, $72,720,63[illegible]. As before each mineral is taken up in its alphabetical order and exhaustively treated, both as to its production in the year, and special processes introduced in connection with each. Under the head of special articles, contributed by experts, we have the following: Pyritic Smelting, Franklin R. Carpenter; The Progress of Metallography in 1900, Albert Sauveur; Manufacture of Titanium and its Alloys, A. T. Rossi; Review of the Literature on Ore Dressing in 1900, R. H. Richards; The Concentration of the Broken Hill (N. S. W.) Sulphide Ores, T. J. Greenway; Recent Contributions to the Science of Ore Deposits, R. W. Raymond; Notes on Electro-Chemistry, C. F. Chandler; Notes on the Concentration of Finely Crushed Ores, W. McDermott; Filter Press Treatment of Slime in Western Australia, J. K. Wilson. After noting the fluctuations in mining stocks for 1900 at the various world centers of mining information, the editors take up—in alphabetical order—the mineral productions of the other countries of the world, including in this section the mineral imports and exports of the United States for five years. A very complete index makes more accessible the vast amount of valuable information here set down.

SMOKELESS POWDER, NITRO-CELLULOSE AND THEORY OF THE CELLULOSE MOLECULE.—By John B. Bernadou, Lieut. U. S. N. New York: John Wiley & Sons. Cloth; 4¾ × 7½ ins.; pp. viii. + 200; illustrated. $2.50.

Gun powder as a propellant of missiles of war held its place, with little modification, for four centuries. But practically within the last decade a new and more powerful powder has been introduced, adapted for use in arms of all calibers, and prepared from a material that was once only used for detonating purposes—now converted into a progressive explosive. In the first half of the last century it was discovered that cellulose, treated with nitric acid, was converted into a highly inflammable or explosive substance; and in 1846 Schönbein produced gun-cotton, the base of the modern smokeless powders. The author of this work explains the development of the nitro-cellulose compound, as set forth in the experiments and deductions of foreign scientists and his personal investigations conducted by order of the U. S. Government, with the view of producing a nitro-cellulose base suitable for conversion into smokeless powder. His own experiments are set out in great detail; though, for reasons which can be guessed at, the exact commercial methods of manufacturing smokeless powder are not explained. The text is devoted rather to the theoretical and experimental discussion of the earlier views regarding the composition and constitution of nitro-cellulose; the conception of progression in relation to composition and constitution, and a

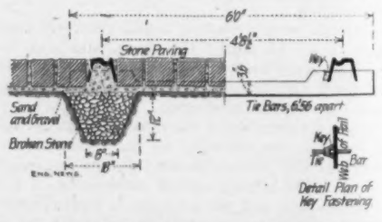


Fig. 2. Cross-Section of Street Railway Track with Demerbe Rails, at Buda-Pesth.

description of solutions of nitro-cellulose and the theory of the cellulose molecule. In the form of appendices the author adds: Researches upon the Nitration of Cotton, by M. Vieille; Pyrocollodion Smokeless Powders, by Prof. D. Mendeleef, and The Nitration of Cotton, by M. Bruley. The author also includes in this same form a lecture delivered by him before the U. S. Naval War College, setting forth the development of smokeless powder, and showing that the first successful step in a change from the old powder to the new was the discovery that nitro-cellulose treated in a certain manner with collodions, and formed into regular grains, would not detonate, but burn in a progressive manner at a rate proportional to the form and size of the grains.

THE "ENGINEERING" AND ELECTRIC TRACTION POCKETBOOK.—By Philip Dawson, Assoc. M. Inst. C. E.; M. I. Mech. E.; M. I. E. E., author of "Electric Railways and Tramways," etc. London: Offices of "Engineering." 35, 36 Bedford St., Strand. New York: John Wiley & Sons. Leather; 4½ × 7 ins.; pp. 1,306; illustrated. $4.

The pocketbook is collated and arranged with special reference to all that relates to electric traction, in its civil, mechanical and electrical engineering phases. Under separate sections it treats of the materials and construction of the track; the return circuit and bonding; the lines and feeders; the power station, with its steam engines and boilers or gas engines; electric generators, switchboards and buildings and accessories; storage batteries; surface and conduit lines; rolling stock and motors; testing methods, efficiency, maintenance, depreciation, and transmission of power. The book is full of tables; over 900 being given in connection with the several subject heads noted above. The latest practice in the United States and in

Screw Propeller with Corrugated Blades.
F. Friedenthal, Preston, England, Inventor.

Europe seems to be noted, described and illustrated. The book is avowedly a compilation; but it is the first of its kind and supplies information that is now widely scattered where accessible at all. A full index to its contents adds largely to the value of the publication.

SEWERAGE.—The Designing, Construction, and Maintenance of Sewerage Systems.—By A. Prescott Folwell, M. Am. Soc. C. E., etc., Associate Professor of Municipal Engineering, Lafayette College. Fourth Edition, Revised and Enlarged. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 × 9 ins.; pp. 445; 29 tables, 13 plates and 38 figures in the text. $3.

The size of this edition has been increased ten pages by the addition of new matter in the section on sewage disposal, and particularly in the chapter devoted to septic tanks, contact filter beds, broad irrigation and intermittent filtration. As the third edition was published in 1900, it seems that the book is meeting with an unusual degree of success.

A SCREW PROPELLER WITH STEPPED BLADES.

In the Holland exhibit at the Paris Exposition last year, there was to be seen a beautifully finished electric launch, built by the firm of L. Smit & Zoon, of Kinderdijk, Holland. The little vessel was equipped with a Tudor battery of 80 cells, designed for a charging current of 75 or 150 volts.

A novel feature of this launch, and one which attracted the attention of thousands of visitors to the Exposition, was the peculiar stepped propeller attached to it, which is shown in the accompanying cut. At our request, Messrs. L. Smit & Zoon have furnished us a brief description of this propeller, which we print as follows:

The propellers used on this launch has corrugated blades, concave on the driving side and only slightly convex on the "go astern" side. These corrugations are composed of curves stepping out from the driving side, slightly finer in pitch on the leading edge and increasing in pitch towards the after or leaving edge, thus effectively arresting the centrifugal tendency of the water along the blade. Moreover, these corrugations are slightly depressed from the leading edge towards the leaving edge; that is to say, they depart from the true helix and are nearer to the axis on which they revolve on the leaving or after edge than they are on the leading or forward edge.

The compression of water may not be a direct forward thrust, but the vertical strain on the blade caused by the compression of the water keeps the blades "taut" and reduces the vibration to a minimum. Indirectly, it saves the power that would otherwise be wasted in vibration. This is an important feature, and a great advantage in electric launches, which are of necessity lightly built, for the least vibration in the stern of the boat is carried through the whole structure to the stem, greatly to the annoyance of all passengers on board. After many exhaustive trials of all designs of propellers on these launches this corrugated propeller has answered the best. It is patented and manufactured by Mr. F. Friedenthal, of Preston, England.

If the theory of the stepped propeller is not clear to any of our readers from the foregoing description, we suggest that they consider that every propeller acts more or less like a centrifugal pump, carrying the water around in a circle and throwing it off at a tangent. Only a perfectly frictionless propeller working in a perfectly frictionless fluid could avoid loss of power in this way. Referring to the illustration of the propeller, it will be seen that the corrugations tend to stop the flow of water radially outward along the blades, and inasmuch as they effect this they should increase the propeller's efficiency.

A NEW STADIA NOTE-BOOK.

In our issue of April 25 last we published a description of a new note-book for stadia surveys devised by Mr. Richard G. Doerflinger, in which alternate pages were ruled with circles and radial lines for the convenient sketching of topography from the stadia readings. We then expressed our approval of the general plan of Mr. Doerflinger's note-book and requested the criticisms of our readers, stating that if these criticisms were generally favorable we would prepare such a book for publication.

The first response to this publication was from Prof. W. P. Mason, of the Rensselaer Polytechnic Institute, who informed us that a book similar in plan to Mr. Doerflinger's had been in use for three years by the engineering students at Harvard University, the book being devised by Prof. D. L. Turner, of that institution. While the correspondence develops that other engineers have conceived similar ideas and have even made books of this sort for their own use, Prof. Turner appears to be the first to cause such a book to be actually printed and sold. We have now arranged with Prof. Turner to undertake the publication and sale of this book, and its form has been somewhat modified in accordance with the numerous suggestions received from various correspondents after the publication of Mr. Doerflinger's letter, on April 25. Lack of space prevents printing all these letters in full, but we take this opportunity of thanking those who favored us with criticisms in response to our request.

In accordance with the suggestions of several, as well as in conformity with the plan followed in the first edition of Prof. Turner's book, the note page of the book is ruled, but the headings are left blank, so that the topographer may adopt any form for notes which he prefers. A convenient form is suggested by Prof. Turner in the preface. The sketch page also is not lettered, so that the topographer can adopt any scale he pleases for distances and make the zero of his circle at any point of the circumference. The radial lines and circles are carried out in the corners to the full width of the page, as suggested by several correspondents.

We print extracts from a few of the letters received, as follows:

Sir: My friends have called me a stadia "crank" for several years because of my habit of using the method for so many purposes, and some time ago I used sketches very freely although many users of the method decry sketching. There is no doubt, however, that it helps greatly for the observer to use sketches and if possible plot as nearly to scale as possible.

Some four years ago I commenced to use a separate little sketch book which I made myself out of sheets of thin cross-section paper ruled 10 to the inch. The sketches were made in the same manner as ordinary sketches of objects each side of a line, i. e., the line run was up the center of the page and the objects were sketched each side of it at right angles. The sketching sheets were stitched together in packages of six or eight, and held in the book by a rubber band. I did not make a sketch at every station occupied.

Last summer I had a survey to make of a valley about 600 to 900 ft. wide and nearly five miles long, and locate every ditch, headgate, water-right notice, house, fence, building, etc.

It was a place where sketching would save a tremendous amount of work. The elevations and contours were not wanted, but I took enough information so that they can be put in if wanted. I decided to use the stadia as the quickest way of doing the work, and concluded the old style of square-ruled sketching sheets might be improved upon. After some thought I made a sketching sheet ruled like M. Doerflinger's with concentric circles. This was traced and a negative made on brown negative paper. With this negative I was able to make prints having blue lines on a white ground, with ordinary blue-print paper.

These sheets were stitched together six and eight in a package and used in the field book by a rubber band passing over the back of the cover and down the fold; but I held them in the back of the book and turned over the pages when I wanted to make a sketch. I can certify that the scheme is an excellent one and if you get out such a stadia field book as you mention you will deserve great credit. Ernest McCullough.

Lewiston, Idaho.

Sir: A slightly modified form of Mr. Doerflinger's scheme was used by at least one of the recorders on the U. S. deep waterways survey (1898-1900) and later on the survey of the Illinois and Des Plaines rivers with very good results in both cases. In the writer's opinion the method would be more generally used by field topographers if its advantages were better known and appreciated.

My recollection is that in the two instances of its use noted above the sketches were much more readily and satisfactorily interpreted by the office draftsmen than those drawn wholly by "eye," and the method is also a good check on the ground covered by the rodmen—as the sketch proceeds with the work, the recorder can tell at a glance just where a few additional "shots" are required and governing points are less likely to be left out than by the old method where the relative positions of points are always distorted in the sketch no matter how good an "eye for country" the recorder may have.

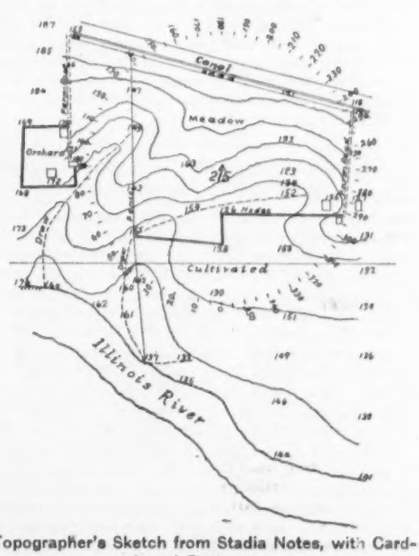
The more nearly a field sketch presents conditions as they exist—that is, the more nearly it is drawn to scale—the more value it has for the purpose for which it is intended; and anything which tends to this result is a step in the right direction and should meet universal approval.

Very respectfully yours, H. Fay Allen.

521 Hickox Bldg., Cleveland, O., May 3, 1901.

Sir: I think all that have had any extensive experience with topographical work, especially the plotting of notes, will agree that field sketches are of the greatest importance and the more nearly the sketch is to scale the more valuable it is.

The proposed scheme is indeed very ingenious, but the following objections might be offered: The sample sketch looks very nice with the topography evenly distributed around the station, but as a rule the greater part of a stadia survey is in connection with a river or a body of water and the stations follow this outline, hence the

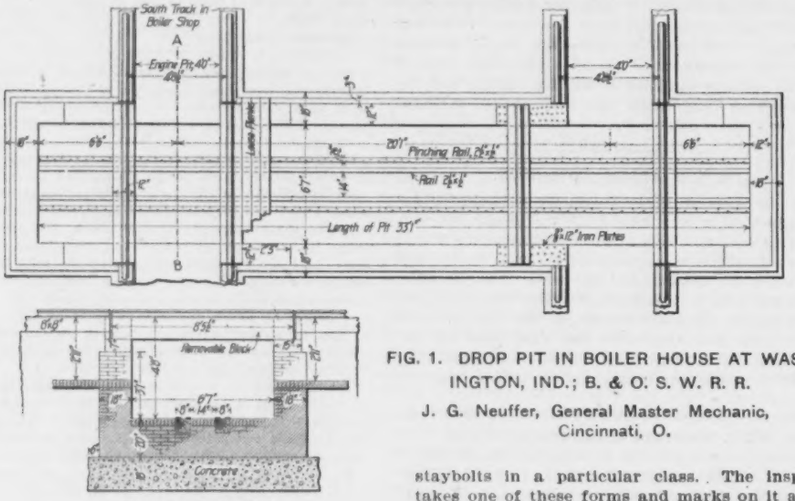


Topographer's Sketch from Stadia Notes, with Cardboard Protractor.

majority of the topography will be on the side of the station opposite the river so that about half of the sketch page by the proposed method will be crowded with the sketch and the other half left blank, this being due to the fact that the proposed ruling is to be put in at the time the note book is made and the station point will no doubt be in the center of the page. Again, it requires a great many lines, which will tend to add confusion to the sketch. It also requires a special book which may not always be convenient or desirable to obtain.

The following method was adopted by Mr. E. E. Hart, then instrumentman on the U. S. deep waterways survey, and later used by me on the recent survey of the Illinois

River: It has the advantage of placing the station on any part of the page, thus securing the most space for the sketch and the sketch is made to scale, has no lines to confuse the sketch, requires no special note book and is simple and rapid. From a piece of drawing paper cut a circle about 2½ ins. in diameter on which 5° points have been drawn with a protractor. While the instrumentman is setting up, the recorder notes the lay of the topography and places the station in the note book accordingly and with this paper circle dots off the 5° points, as shown by the accompanying sketch, which is traced from the sketch page of a note book. After recording the reading and while the instrumentman is making the next pointing



Transverse Section A-B.

FIG. 1. DROP PIT IN BOILER HOUSE AT WASHINGTON, IND.; B. & O. S. W. R. R.

J. G. Neuffer, General Master Mechanic, Cincinnati, O.

the recorder with a small scale of equal parts simply plots the last reading just as is done on a map; 500 shots may be easily plotted in a day by this method, and I have seen a double-page sketch made in this way on which 806 shots were plotted from one station. The numbers on the sketch refer to the number of the shots in the notes. Very respectfully, W. C. Bunnel.

Engineer Office, U. S. Army,
Charleston, S. C., May 2, 1901.

The scheme described by the last correspondent will no doubt prove useful under many circumstances. In regard to the criticism that the ruling in circles and radial lines on the sketch page of Prof. Turner's book will confuse the drawing, we may remark that as these lines are printed in a pale tint, we believe no trouble of this sort will be found in practice.

NOTES ON LOCOMOTIVE SHOP PRACTICE; BALTIMORE & OHIO SOUTHWESTERN RY.

In the boiler shop of the Baltimore & Ohio Southwestern Ry., at Washington, Ind., is a drop-pit for removing driving wheels, the construction of which is shown in Fig. 1. The drop-pit extends between, and slightly beyond, two of the engine pits, the tracks of the latter being carried across by short pieces of rails on stringers 12 × 12 ins., which can be removed when the drop-pit is to be used. The pit is 33 ft. long and 6 ft. 7 ins. wide with brick walls and bottom, and has strap iron tracks for the truck carrying the wheel jack. These are spiked to stringers 8 × 8 ins. in the floor. The depth below base of rail is 4 ft. 8 ins. at one end and 4 ft. 8½ ins. at the other, while the engine pits are 2 ft. 11 ins. deep. The arrangement is such that a pair of wheels may be lowered from the engine over either pit, wheeled on a small truck to the adjoining pit, and there raised and rolled away on the track. The pit truck is of the four-wheeled type and runs on the two inner strap rails, ½ × 2½ ins.; the axles extend beyond the wheels, so as to give a bearing for a pinch bar, the end of which is worked on the outer strap rail. It is only necessary to use the bar in exceptional cases, when the truck binds on the rails or to start it along the track. The truck carries a telescoping jack, the plunger of which has its end shaped to fit the axle of the engine.

In the roundhouse is a smaller drop-pit of the same kind, which is used for removing the truck wheels of consolidation engines. This pit is so located that the truck wheels may be removed while the engine is standing under the smokejack. The pit is 3 ft. 4 ins. wide, 1 ft. 7 ins. deep at one end and 1 ft. 6½ ins. at the other. It is spanned by removable pieces of rail on stringers 6 × 12 ins., and has floor stringers and a strap rail track for the truck carrying the wheel jack.

In Fig. 2 is shown a printed form used in these shops for recording defective staybolts. The form is 6 × 12½ ins. on the border line and shows the number and position of staybolts. Different forms are required for different classes of engines, each form showing the relative positions of all the staybolts in a particular class. The inspector takes one of these forms and marks on it all the defective staybolts which he finds. The form is then given to the foreman of the boiler shop, who satisfies himself that it has been correctly filled out, and then transmits it to the division master mechanic, who keeps it on file in his office for future reference.

In the roundhouse at Washington, above mentioned, there is a rather novel arrangement for blowing off steam. The dome of every engine is fitted with an elbow and globe valve, and over each stall is a pipe extending through the roof. When an engine is run into the house and its smokestack is under the smokejack, the elbow is coupled up to the pipe by a flexible hose, and the globe valve opened. All steam is thus discharged outside the building, and there is no dripping of water and wet soot to injure the boiler jacket.

Four-cylinder Vauclain compounds are very extensively used on this road in passenger and freight service, and show an average economy of 15% in fuel consumption as compared with simple engines. On individual engines the economy varies from 12 to 22%, according to the service. The cost of maintenance and repairs is found to be practically the same as for simple engines.

For information respecting the above details of practice we are indebted to Mr. J. G. Neuffer, General Master Mechanic of the B. & O. S. W. Ry., at Cincinnati, O.

FIG. 2. FORM USED FOR RECORDING DEFECTIVE STAYBOLTS; B. & O. S. W. R. R.

THE KOREAN SEOUL-FUSAN RAILWAY ... now being surveyed for a Japanese syndicate, which ... the guarantee of the Japanese government for 15 ... interest on its bonds at 6%. The extreme estimate ... cost is 25,000,000 yen, or $12,500,000. The road would ... 287 miles long; would open up the rich southern ports ... of Korea, and will extend Japanese influence. Mr. Ho... N. Allen, U. S. Consul-General at Seoul, thinks that ... line will afford a favorable opportunity for the introduction of American railway supplies, as the line will be built after American methods. There will be ... tunnels on the road, aggregating 40,700 ft. in length, and the total length of bridges will be 20,500 ft. ... age will be 4 ft. 8 ins., and 75-lb. rails will be used. Stone is plentiful, but American timber will probably be employed for ties, bridges and buildings. Korean labor, says the "Japan Daily Mail," is good, and the pay does not exceed 21 Japanese sen, or 10½ cts. gold per day.

THE PROSPECTIVE OPENING OF THE SIMPLON tunnel has led the French Government to investigate the probable railway connections upon French territory. It is expected that this last tunnel through the Alps will be completed in about 20 months, and the French estimate that the Saint Gothard tunnel alone represented a loss to the French railways of $10,000,000 per year by the diversion of traffic. The Simplon route will still further shorten the line of travel from the North of Europe to Italy, and the maximum gradient is 1%, as against 2.7% in the Saint Gothard and Mont Cenis tunnels. As a consequence the Paris, Lyons & Mediterranean Railway Co. is considering two projects for shortening its line. The most important of these contemplates a 10-mile tunnel through the Juras, at Faucille, with an extension of the line from Lons le Saunier, through a series of tunnels, to Faucille, and then to join the Swiss Jura-Simplon Railway beyond. The total length of the tunnels required would be about 18 miles, and the estimated cost is $26,000,000. Another project calls for connecting the Faucille line with the railway from Bellegarde to Saint Maurice.

THE NEW METAL RADIUM, says Mr. P. Besson in a recent paper read before the Paris Society of Civil Engineers, is being produced commercially by the Societe Centrale de Produits Chimiques. It takes over one ton of the minerals of the uranium group to produce one-half ounce of radium; and to separate this half ounce from the other material requires the use of 6 tons of chemicals and 50 tons of water for washing purposes. Radium, a new element and metal, has unusual properties in a pure state. It is spontaneously luminous in the dark; and while scientists are not yet agreed as to the cause, it is thought to be due to the continuous emission of extremely minute highly electrified particles, almost similar to the X-rays. These particles carry an astonishingly heavy charge of electricity, while the mass of the particles is so extremely small that the loss in weight by radiation is infinitesimal. Tests show that this loss is only one milligram in 100,000,000 years. No use is yet known for radium outside laboratory experiments.

THE CHICAGO DRAINAGE CANAL will have its flow increased from 200,000 cu. ft. to 300,000 cu. ft. per minute, between the hours of 4 p. m. and midnight, according to a permit granted by the Secretary of War. The flow was formerly 300,000 cu. ft., but a few months ago the vessel interests claimed this caused too great a current in the Chicago River, and the rate was ordered reduced to 200,000 cu. ft. Now, however, the interests along the Desplaines and Illinois rivers claim that the supply of water is insufficient, and the flow is therefore to be increased at night when the current in the Chicago River will not affect navigation.

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